Iron and Steel ENGINEER

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AUGUST, 1959

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DETROIT

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PITTSBURGH, PENNSYLVANIA, U.S.A.

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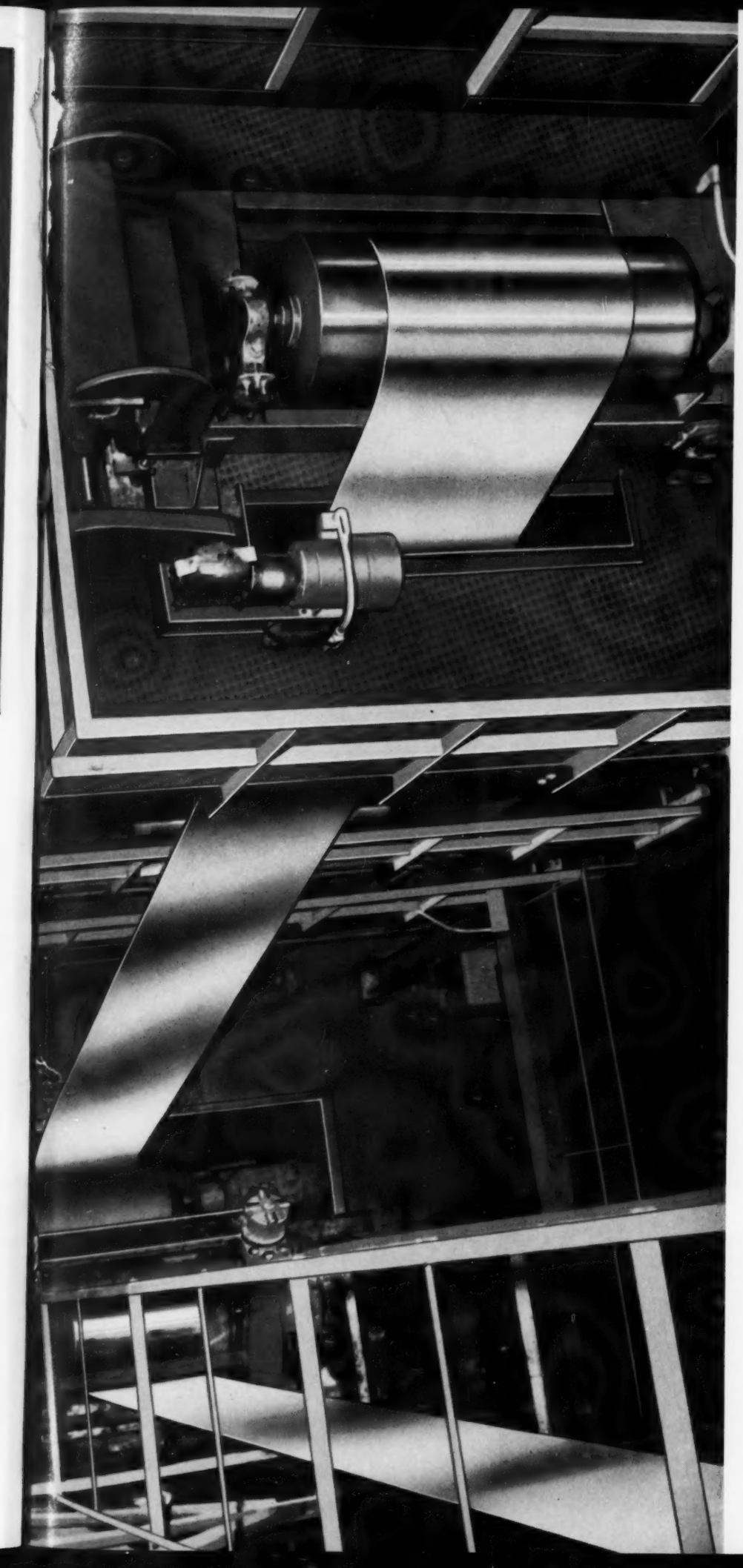

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STURDY, COMPACT HOUSINGS of cast gray iron or cast steel provide exceptional strength where needed, without excess size or weight.

RELIABLE LUBRICATION — Holes for grease cups or pressure fittings are drilled and tapped. Grooves distribute lubricant over entire shaft surface.

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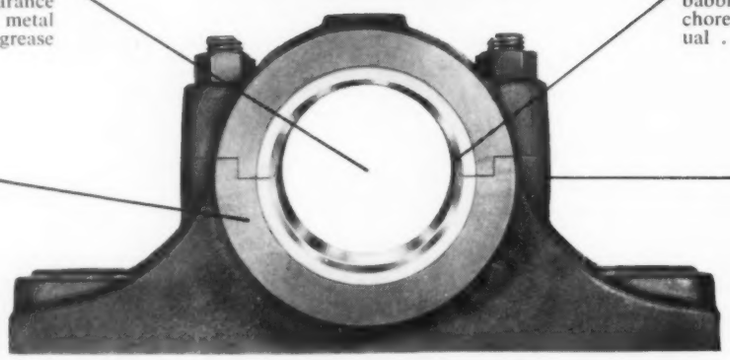

FINISHED ENDS permit flush mounting of sprockets, pulleys, wheels and collars against bearing.

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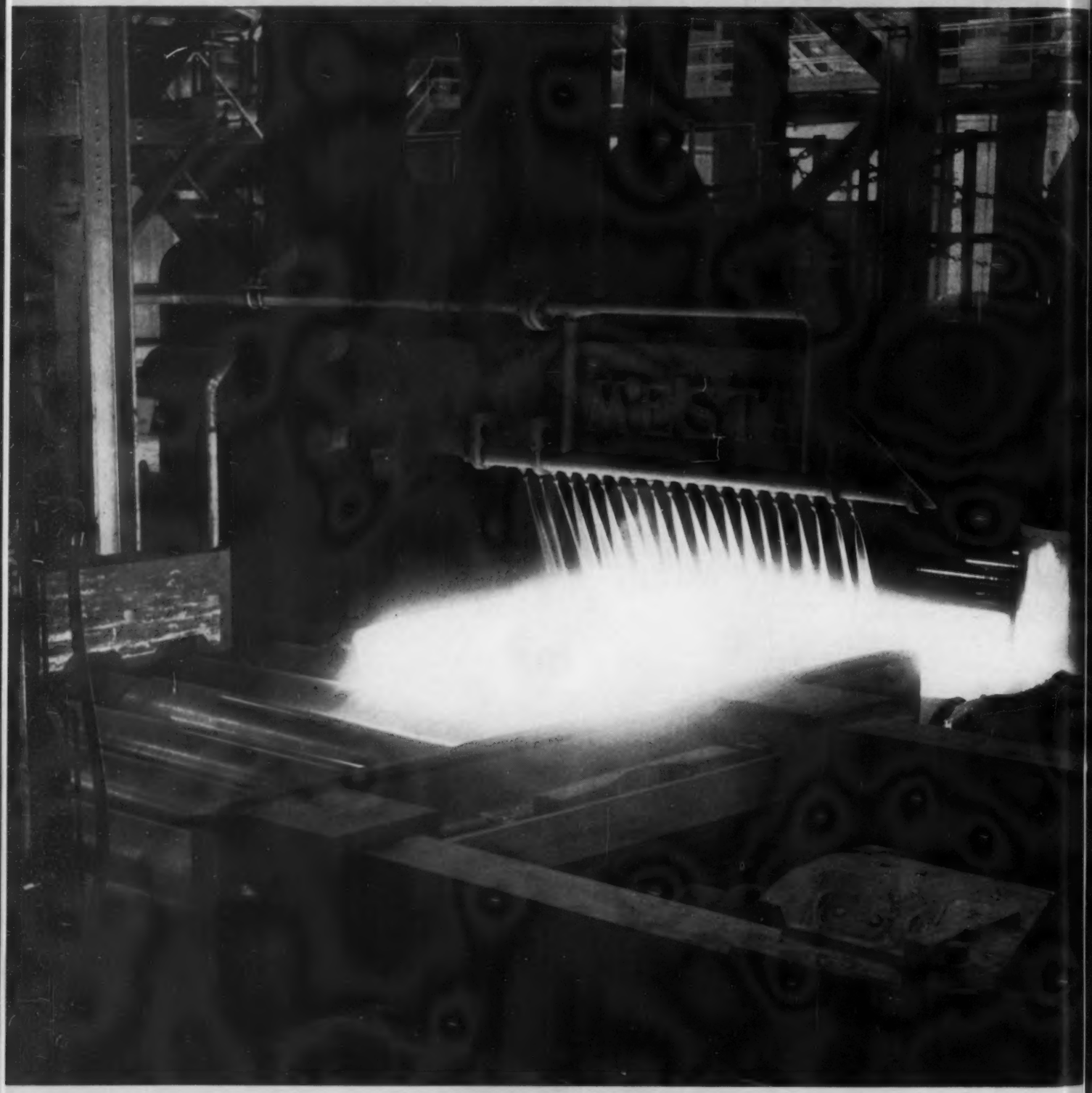
DE LAVAL
CENTRIFUGAL PUMPS

for high-pressure

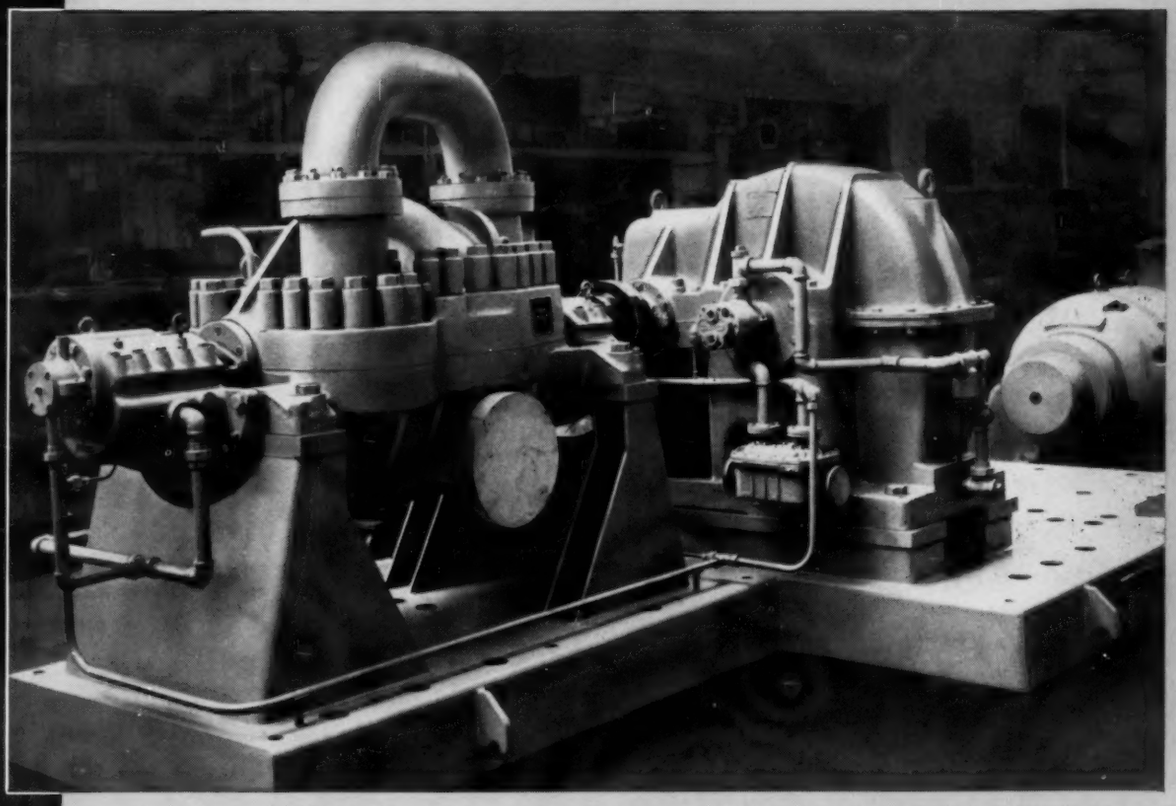


descaling at Lukens Steel

Latest successful technique of high-pressure descaling is now being performed in this modern steelmaking facility designed by Mesta Machine Co.

The initial high-pressure descaling operation uses De Laval split-case multi-stage pumps as shown in the photograph below. Each pump supplies cold water at 1000 gpm and 1600 psig. Electric motors rated at 1750 hp drive the pumps through speed increasers which raise the speed from 1200 rpm to 4250 rpm.

De Laval pumps also serve Lukens on a 1200 psig descaling system in another section of the Coatesville, Pa. mill.



One of several arrangements available for descaling service at pressures of 1000-1200-1600 psig and capacities to 2200 gpm.

DE LAVAL *Steam Turbine Company*

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DL-670

J&L, too, relies on *Lee Wilson* single stacks for finest chrome-stainless annealing!

No special atmosphere required... uniformity of physical properties declared excellent—Exacting uniformity of anneal is particularly desirous in chromium stainless steels. To make sure of the finest possible annealing Jones & Laughlin selected Lee Wilson single stack furnaces for their new Stainless and Strip Division plant at Louisville, Ohio.

No special atmosphere is required. The anneal develops a type of scale which is easily removed. The four furnaces and eight bases have capacity for 2800 tons per month.

Designed specifically for stainless annealing the installation includes cast alloy convector plates, oil-lubricated fan drive and alloy fan wheel designed to operate up to 1600°F. Because charges are uncovered at high temperatures heat shields have been installed between bases.

Standard or special Lee Wilson single stack furnaces are unequalled when it comes to quality, production and versatility.

Jones & Laughlin can process 2800 tons per month of chrome-stainless through the four Lee Wilson single stack annealing furnaces pictured above.

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MAKE THE BEST METALS BETTER

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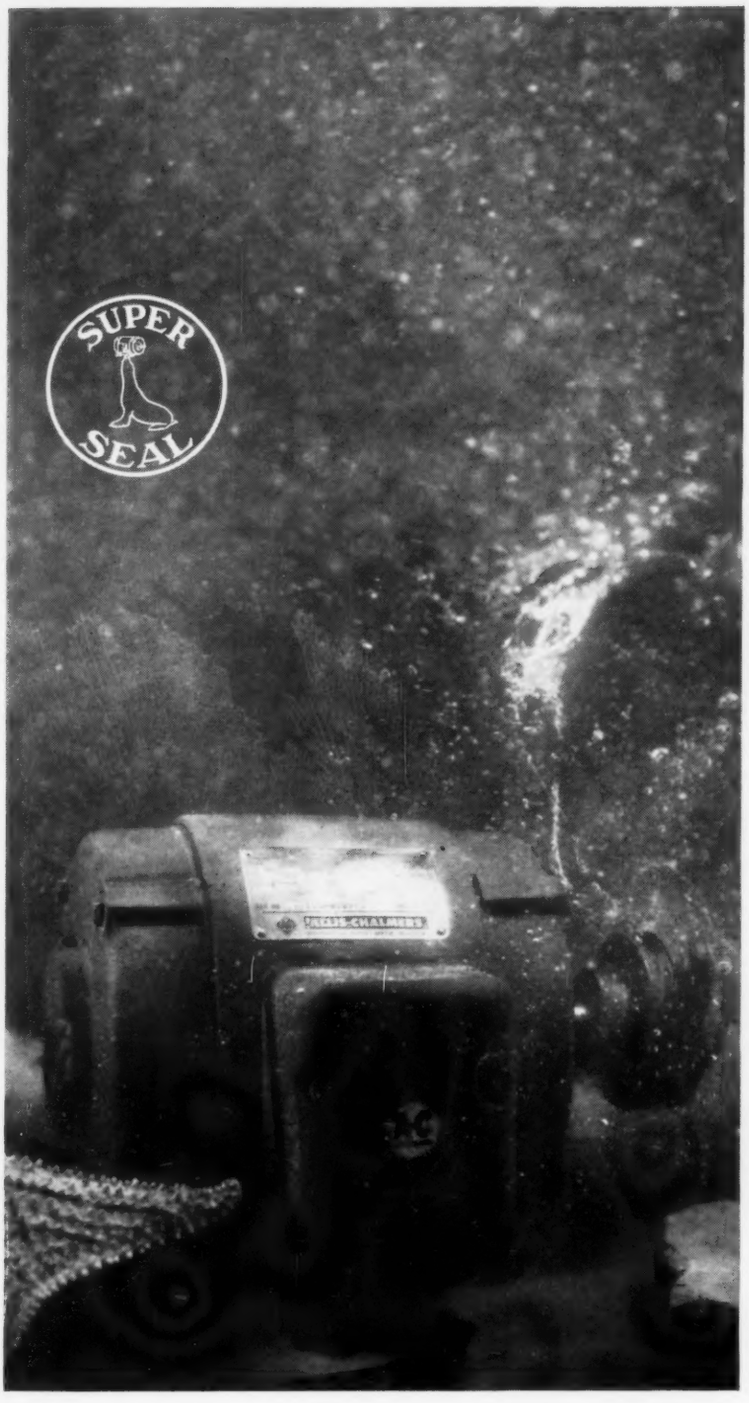

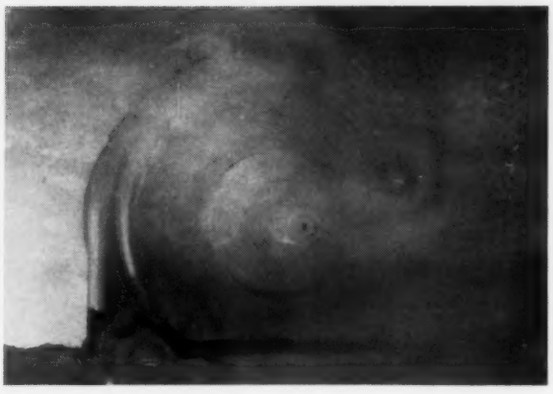

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ALLIS-CHALMERS A-1151

Now SKF has improved the spherical roller bearing it invented!

This new spherical roller bearing offers even higher capacity than SKF's original, self-aligning bearing – and meets the needs of today's faster, more productive machinery. In some cases, the increase in capacity is as much as 54% – corresponding to more than 4 times longer service life!

Here's how these improvements have been obtained:

1. Eliminating undercuts and integral flanges – helps provide space for larger rollers and longer effective contact between rollers and races.

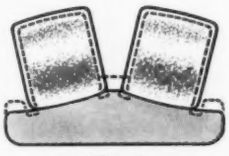

Fig. 1

Fig. 2

2. Using symmetrical rollers, unrestricted by flanges – ensures uniform load distribution over the roller length at all times, even under heavy thrust load.

3. Using an axially floating guide ring – provides effective roller guiding, and minimizes friction at roller ends.

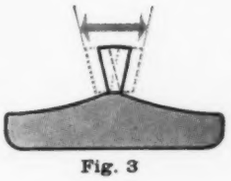

Fig. 3

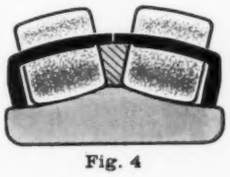

Fig. 4

4. Using a strong "window-type" cage for each row of rollers—helps ensure dependable operation over a full range of loads and speeds.

5. Placing a lubricant duct in the center of the outer ring—helps channel lubricants directly to the rollers and push contaminants away.

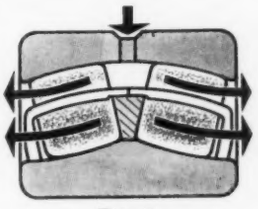

Fig. 5

For full details on this new high-capacity spherical roller bearing call the nearest SKF sales office or authorized SKF distributor listed in the yellow pages of the telephone book.

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Spherical, Cylindrical, Ball, and Tyson Tapered Roller Bearings

EVERY TYPE—EVERY USE

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CLEVELAND CRANES
MODERN ALL-WELDED STEEL MILL CRANES
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Crops and Shorts

△ For the sixth time in 13 years, the steel industry is closed down by a strike, in spite of "expert" mouthings to the last that there would be no strike. Actually, it is a strike that had to come. It is a strike that may well be duplicated in other industries.

Union leaders have come to look on automatic annual wage increases as their just desserts. The result of unmerited increases has been higher prices and inflation. Also, mulish insistence on work practices once justifiable but since rendered obsolete by changed conditions has become a serious matter.

To the credit of the industry, it has apparently decided to resist firmly the inflationary "give-in-and-raise-price" policy and to gain back management prerogatives carelessly frittered away in previous bargaining. The industry offered a modest wage increase and other benefits in return for rewritten contract clauses that would discourage wildcat strikes and permit management to take economic steps that would offset the costs of the increases.

The union characteristically says the steel companies will not bargain but want the strike. Further, it protests that it has never opposed technical progress, ignoring completely the hundreds of cases of "feather-bedding" it has forced on the industry.

△ So the question goes "how long will it be?" In 1946, 28 days, 18½ cents an hour increase; 42 days in 1949, pensions and insurance; in 1952, 58 days, 12½ cents an hour increase in base pay and union security; in 1955, one day, 11½ cents an hour increase; 34 days in 1956, 10½ cent hourly increase and 9.1 cents escalator raises over two years. In 1959——?

△ Adding ammunition for the union's guns are the first-half financial statements of steel companies, which for the most part show record production, record sales and record profits.

△ The only thing wrong with industry's stand against inflation is that it should have started some years ago. There is plenty of evidence that we are pricing ourselves out of our markets. Automobile exports are down, imports up. Steel imports in many forms are increasing while exports drop. U. S. imports in 1958 totaled 1,702,819 tons, up 48 per cent over the 1,152,549 tons of 1957. Exports totaled 2,687,415 tons, down 48 per cent under 1957's 5,175,488 tons. Exports of cotton, wheat, etc., show lesser but similar trends. Machine tool exports have dropped, imports increased.

American industries have been able to hold their own in the past because of technical know-how and mass-production efficiency. Many foreign manufacturers, aided in many cases by American money, now have plants just as efficient as ours. We can no longer discount the low foreign wages by higher efficiency.

The fellow who used to "get it wholesale"—can now buy it cheaper abroad.

△ Another point the steel industry can no longer ignore is competition from other materials. Aluminum is now being considered in fields formerly monopolized by steel, such as cans, railroad cars, military equipment, architectural specialties, etc. Aluminum conduit is available at costs only 6 to 7 per cent above that of steel. Aluminum collector rails are said to be cheaper than steel rails with a copper carrier cable. Plastics have cut in to replace metals in many applications. Higher prices for steel can only hasten these trends.

△ An ironic coincidence was the start-up of Alaska Steel Mills, Inc., in Seattle, Wash., on July 20, the eve of the general strike. The company at present is producing reinforcing bar.

The company is owned and financed by Alaska people and the mill will be moved to Fairbanks when a power plant now under construction is completed.

The equipment now in Seattle was formerly a part of the Seidelhuber Iron and Bronze Works.

△ A local playboy has invented a drink he calls the wow. It's made of sugar, beef extract and whisky. The sugar gives energy, the beef extract strength and the whisky ideas of what to do with the energy and strength.

△ Final production figures for the iron and steel industry for the first half of 1959 total new records of 42,393,666 tons of pig iron and ferroalloys and 64,278,569 tons of steel.

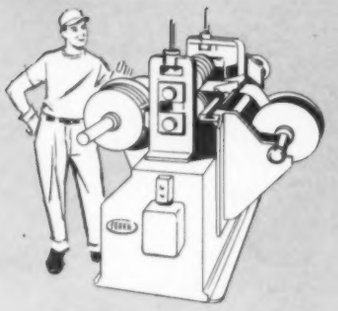
△ Items in the news remind us that the football season will soon be with us. A University of Denver football player was awarded workmen's compensation for a football injury. Also, a new football stadium at West Texas State College has outlets for spectators' electric blankets.

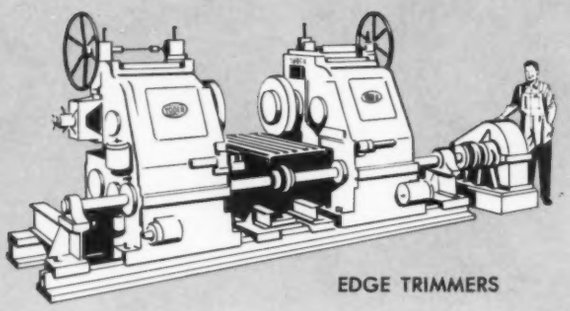
△ One week after the start of the strike, about 30 strikers applied for public assistance in Allegheny County, Pennsylvania. One of these was reported to be an unusual case in that the man was involved in a wildcat strike in the pay period preceding the general strike. This man will receive $175 a month minus any other income he picks up, as long as he is in need.

This public assistance is available to any resident of Pennsylvania who is hungry and destitute. It comes from the tax money, to which industry is a heavy contributor. Ironically, it is used to help strikers who close down industry. Isn't that the union's job?

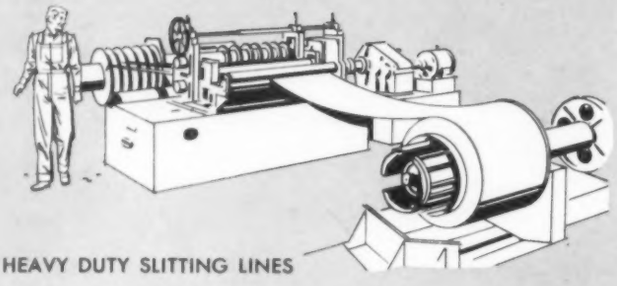
△ Cigaret makers continue to experiment with their product. Following on the heels of double filters came triple filters, additives to absorb nicotine and heavy tars, and even a cigaret containing no tobacco but, instead, a vegetable fiber said to be free from cigaret tars, nicotine and arsenic. Lest a million-dollar idea be overlooked we might suggest a tip made of solid plaster-of-Paris.

SELF-CONTAINED SLITTERS





EDGE TRIMMERS



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basic equipment for cost-conscious users of strip!

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YODER accessories, such as coil cars, swivel unloaders, scrap choppers, scrap disposers, plate levelers and coil boxes, make stock handling fast and easy.

YODER also makes a complete line of Cold Roll-Forming equipment and Pipe and Tube Mills. To profit from YODER'S years of engineering and service experience, contact your local YODER representative or send for the fully illustrated descriptive, YODER Slitter Manual; it's yours for the asking. Write to

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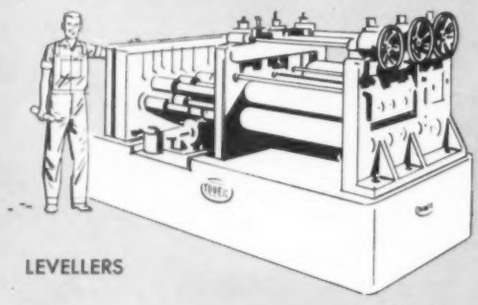

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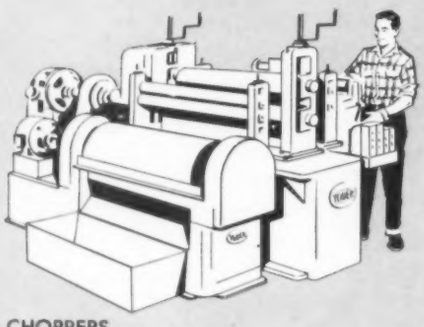

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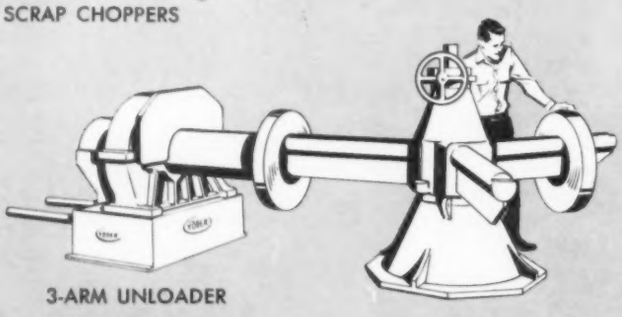
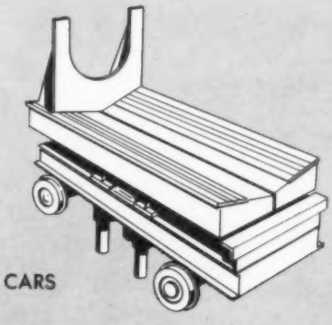


3-ARM UNLOADER

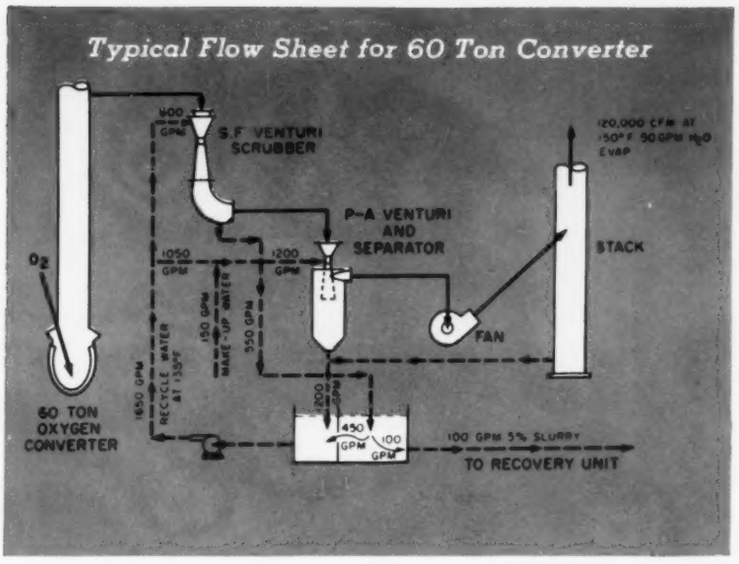


COIL CARS

ENGINEERING YODER MANUFACTURING

ROTARY SLITTING LINES

PIPE AND TUBE MILLS (ferrous or non-ferrous)
COLD ROLL FORMING MACHINES



"virtually no maintenance since start-up on CHEMICO VENTURI WASHERS"

Where major investments are concerned, performance is vital. At the Algoma Steel Company's new Sault Ste. Marie Basic Oxygen Steel plant, Chemico Venturi washers are exceeding all original performance specifications. Case in point: since start-up in November, 1958, there has been virtually no maintenance on the Chemico washers. This is a normal record for Chemico washers. They are designed to eliminate shut downs for maintenance on gas washing systems, thus making it unnecessary to invest in spare equipment.

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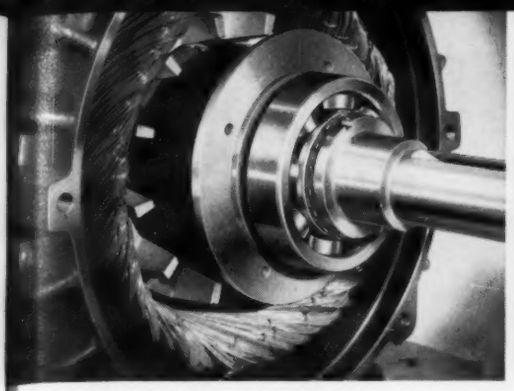

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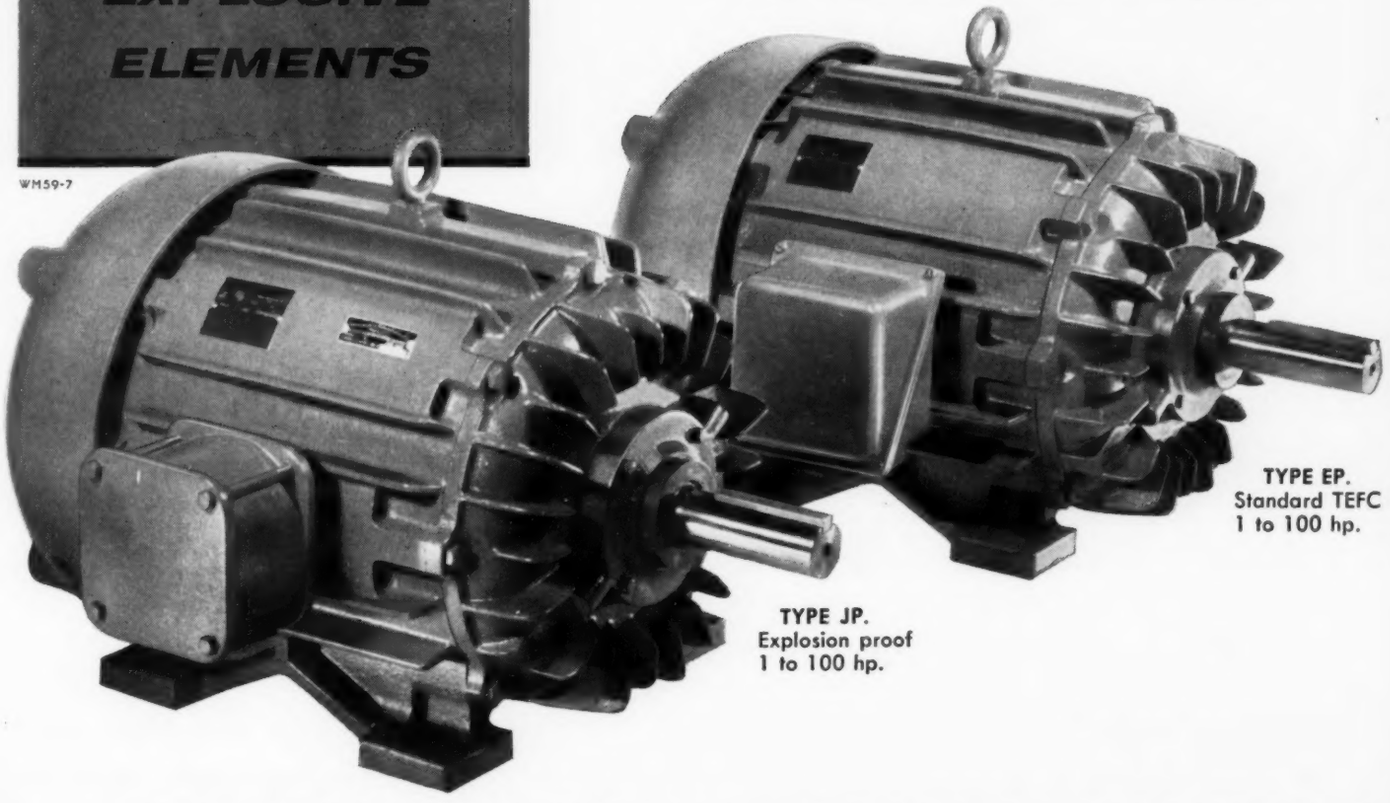

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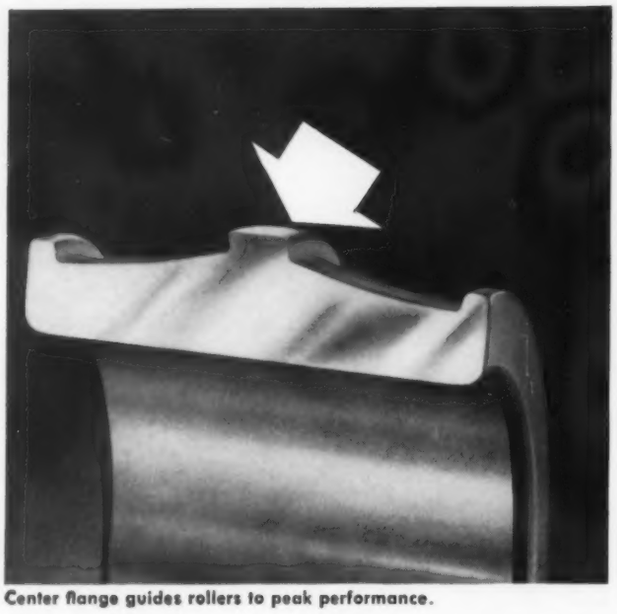

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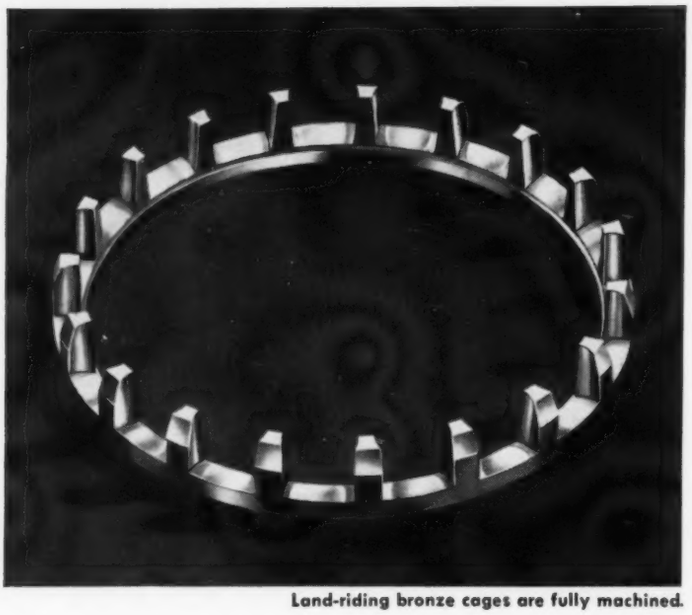

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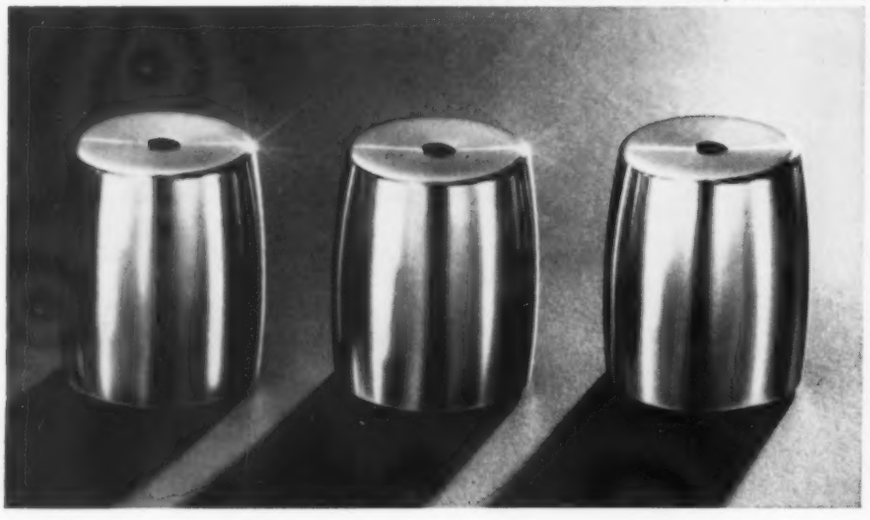

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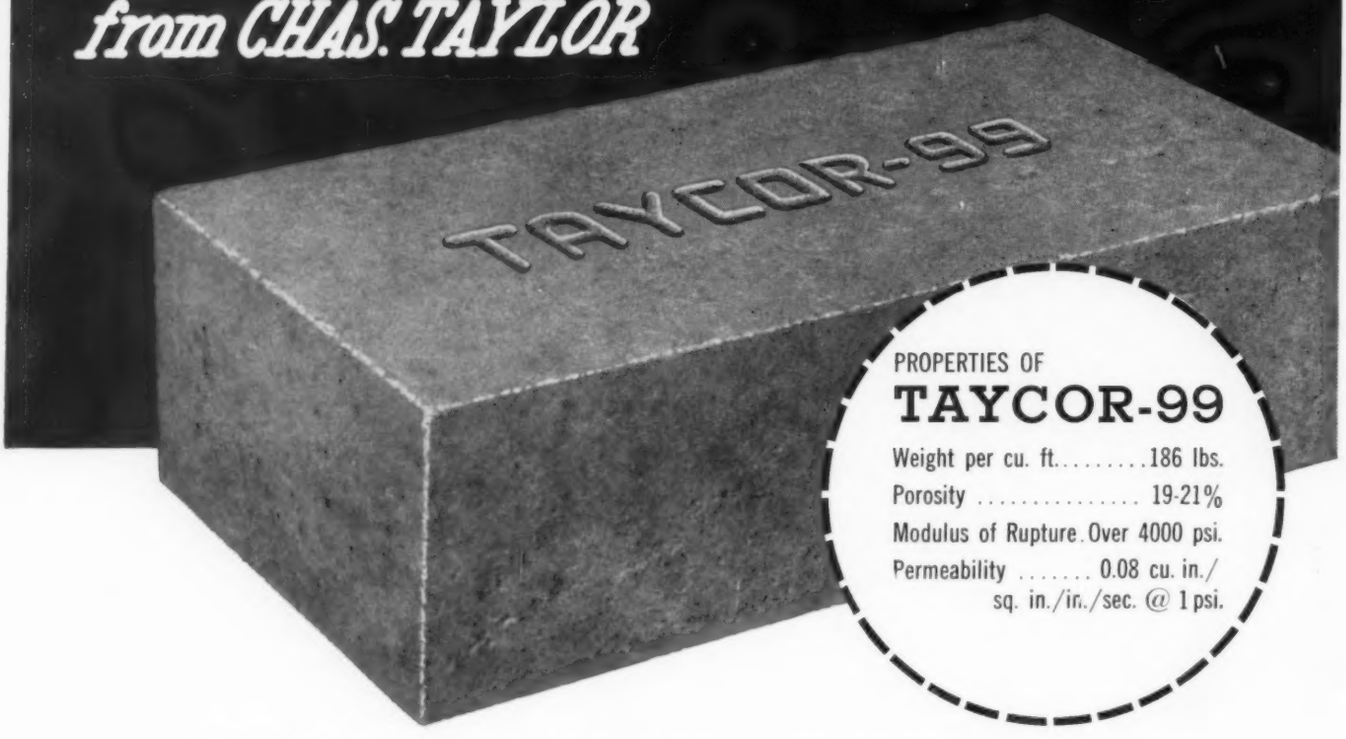

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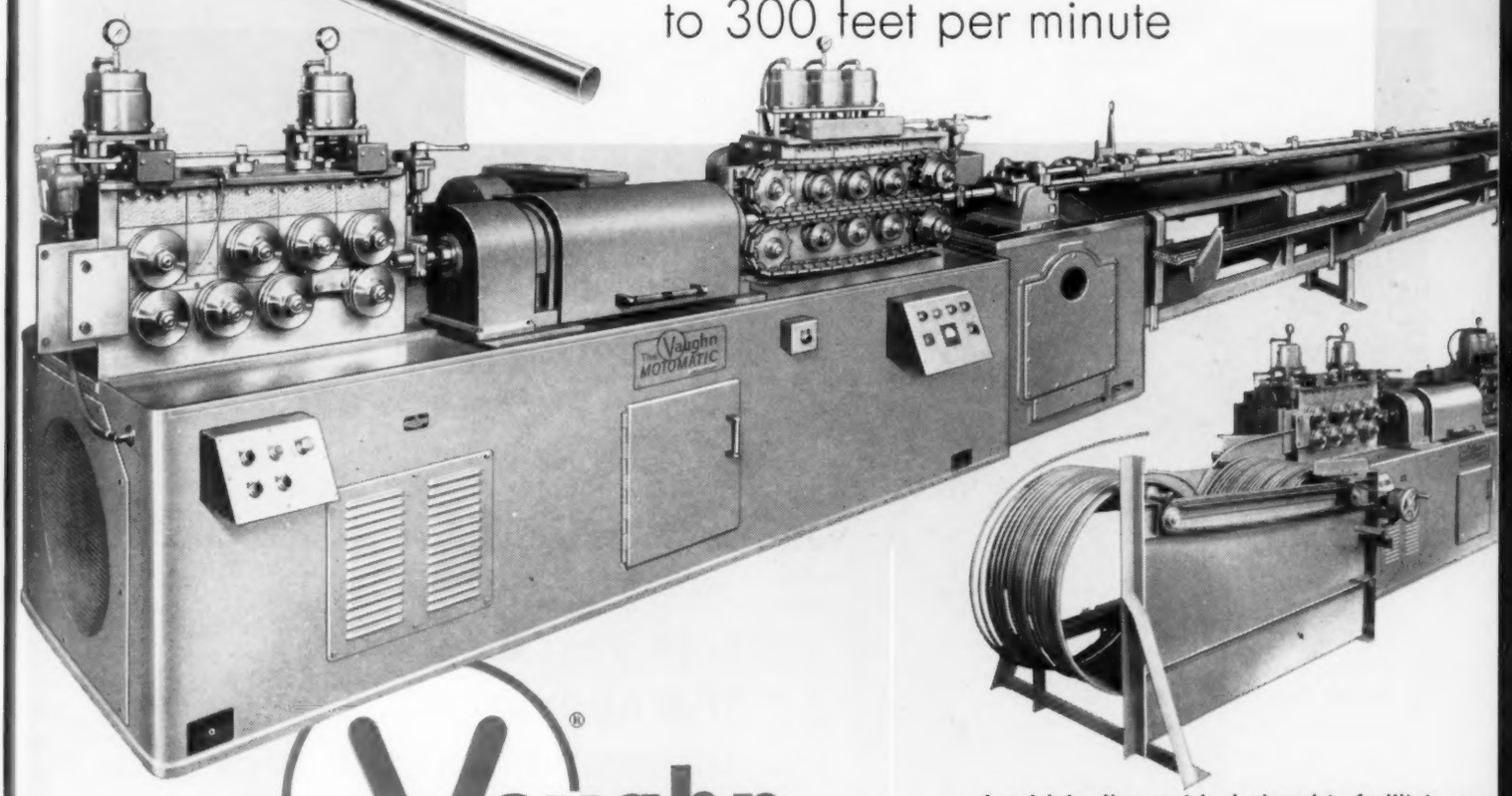

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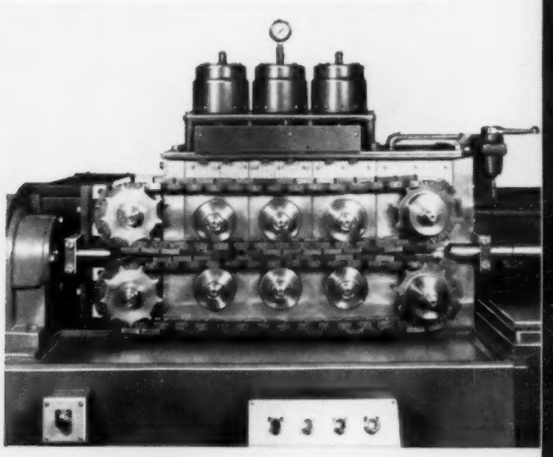

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patent reviews

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period February 24, 1959 through March 17, 1959.

PRODUCTION OF BESSEMER OR CONVERTER STEEL

△ U. S. 2,875,037, issued Feb. 24, 1959 to Edwin C. Wright, assigned to Pennsylvania Engineering Corp., describes a bessemer process which it is claimed can produce steel equal in quality to the best steel made by open hearth and electric furnace procedures.

A two step process is used. In the first step, silicon, manganese, and part of the carbon is removed by a bottom blow in an acid-lined converter. The temperature is then reduced to about 1420 C by the addition of steel scrap. The slag is then removed and the molten metal is delivered to a side blow basic-lined converter, in which the phosphorus content of the bath and the carbon remaining in the bath are decreased.

The steel is extremely low in nitrogen (0.005 per cent) and of low phosphorus content, regardless of the initial phosphorus content.

ROD DESCALER

△ U. S. 2,874,451, issued Feb. 24, 1959 to Warren Ailes, David J. George and Stephen E. Tarby, assigned to United States Steel Corp., describes a device for descaling hot-rolled wire rod prior to drawing.

The device is shown in Figure 1.

It will be evident that rod 27, in being drawn around the sheaves 25, 28 and 30 successively, is bent back and forth in several different planes. As a result, the scale adhering to it is thoroughly broken up and effectively detached and falls into collecting box 20. Thus the rod leaving the apparatus will be clean and scale-free, ready for drawing, coating or other processing as desired. A sloping deflector plate 35 guides any scale particles falling into the box. When the box is full, it is manually removed for disposal of the collected scale and replaced by an empty box.

INTRODUCTION OF OXYGEN INTO THE OPEN HEARTH FURNACE

△ U. S. 2,878,115, issued March 17, 1959 to Philip Schane, Jr. and Willard U. Taylor, assigned to United States Steel Corp., describes a method for introducing oxygen directly into the molten bath in the open-hearth process during the period following the molten iron addition until carbon is reduced to about the desired level.

Figure 1

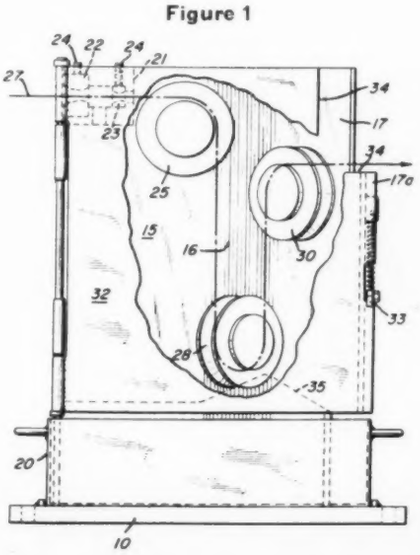


Figure 2 shows schematically a lance 4 for adding oxygen to an open-hearth furnace 2. The lance is retractably mounted so that it can be lowered to proper operating position and withdrawn during charging and tapping.

As shown in Figure 3, the lance is connected to a suitable supply of oxygen as at 9.

The lance 4 is equipped with a water-jacket 14 having a suitable inlet and outlet 13 and 13a enclosing six oxygen discharge tubes 16 connected to a header 18 and terminating in the discharge orifices 6 in the end plate 20.

The operational losses and difficulties occasioned by excessive splashing and fuming which have heretofore prevented the use of oxygen in the open hearth when the bath contains more than about 0.3 per cent carbon are avoided by the following practices.

The charge is calculated in the usual manner, that is, quantities of scrap and hot metal may be any that fit the practices of the individual open hearth shop; the quantities of lime and ore, as dictated by the quantities and analyses of scrap and hot metal to be charged. If desired, the iron oxide requirement may be reduced to allow for oxygen

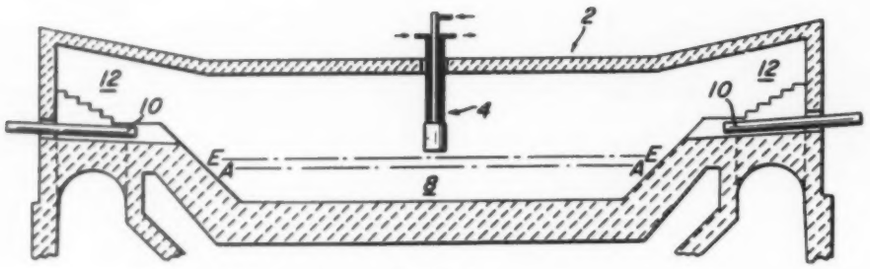


Figure 2

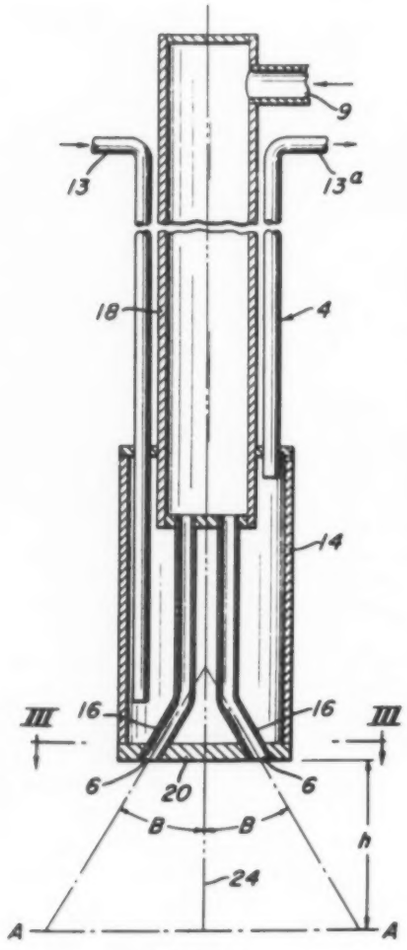


Figure 3

supplied by the lance during refining.

Any normal charging pattern can be used except that those practices known to produce violent boiling during the early stages of the refining should be avoided. Such boiling is particularly undesirable in the vicinity of the lance and for this reason limestone should not be charged in the area immediately below the lance.

The amount of oxygen used during the refining period, i.e., introduced after the hot metal is charged, will be between 200 and 1000 cu ft per ton of steel produced, applied at an input rate of 50 to 300 cfhr per ton of furnace capacity.

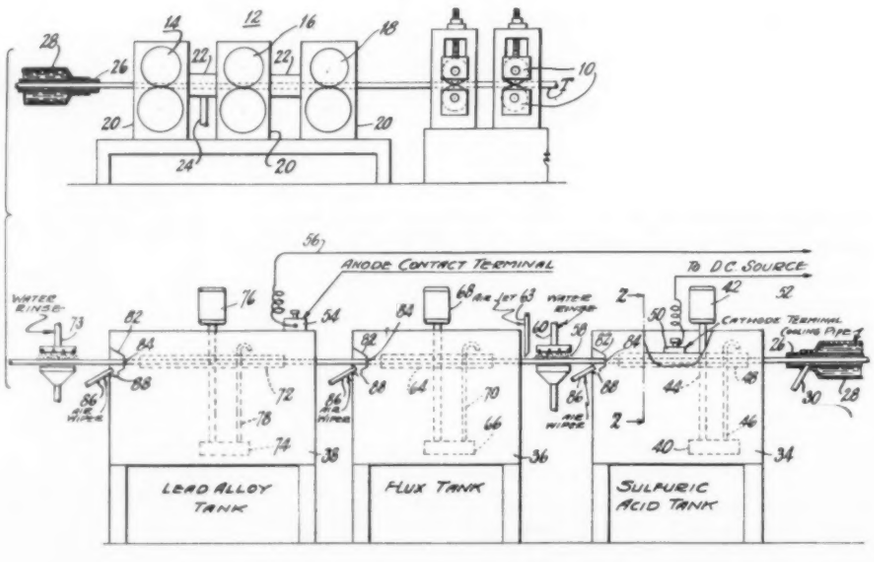
PROCESS OF COATING STEEL TUBING

△ U. S. 2,876,132, issued March 3, 1959 to Donald P. Worden, Roger Young and Willard H. Janneck, assigned to General Motors Corp., describes an improved method of applying to steel tubing a thin layer of a nonferrous and noncorrosive coating to protect the tubing against oxidation or other corrosive action, and a suitable apparatus for carrying out such method. The process which is the subject of the present invention was designed particularly for the purpose of applying a protective coating to steel tubing formed from a flat strip by a continuous process in which the strip is bent into a tube having a seam at the top which is continuously welded as the tube is continuously formed from the strip, the coating being applied to the formed and welded tube as it is moved continuously from the tubing apparatus, the tubing after it leaves such apparatus passing through devices designed to apply the coating thereto which are located adjacent such apparatus.

As shown in Figure 4, after the tube passes the cutting tool it goes through several pairs of sizing rolls indicated at 10. These rolls form the tube in exactly the shape and size desired. After the tube leaves the sizing rolls 10 it is moved through an annealing device 12 which consists of several pairs of rolls 14, 16 and 18 which are the contact rolls of an electric heating device. These pairs of rolls are in housings 20 which are connected by short tubes 22 of refractory material through which the tube T passes. In the annealing device the temperature of the tubing is raised to a point between 1500 and 2000 F in the presence of a reducing gas which is introduced through the conduit 24. Subsequent to the annealing operation the tubing is cooled by passage through a pipe 26 provided with a water jacket 28 and a reducing gas is also introduced into the pipe 26 through a conduit 30, at the rate of 250 to 500 cfhr, depending on the amount required to produce a tube having a surface of the desired brightness.

The apparatus for applying the noncorrosive coating to the tubing is positioned adjacent the tube forming apparatus so that as the formed tube leaves the cooling device it is moved on through the mechanism for applying such coating. As illustrated, this apparatus includes three tanks 34, 36 and 38 through which the tubing passes successively as it leaves the water jacketed cooling pipe 26. The tank at the right 34, through which the tube passes

Figure 4



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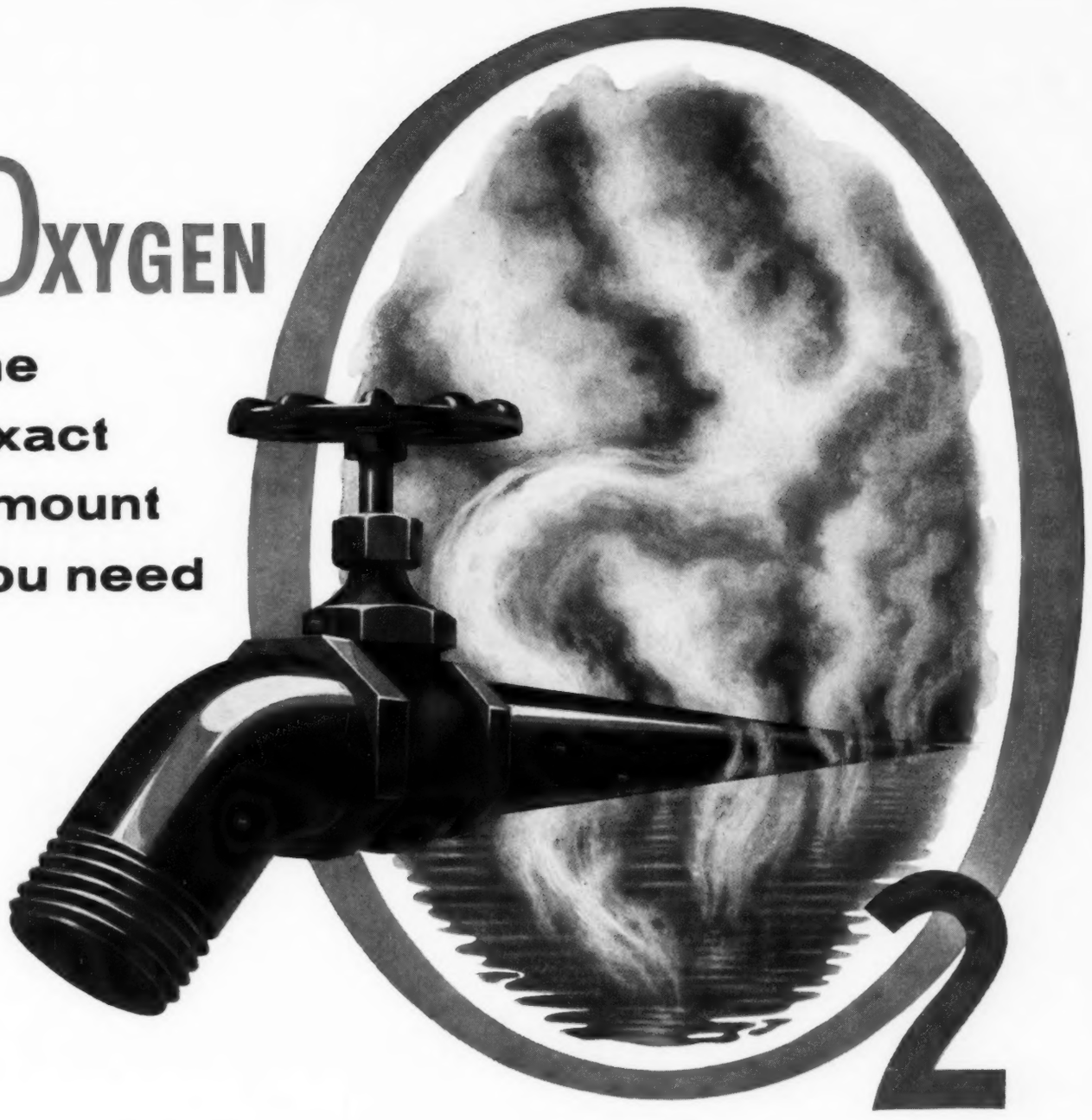

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first contains dilute sulphuric acid which cleans off any oxides or other impurities on the tube surface by electrolytic action. The second tank, 36, through which the tubing passes contains a suitable flux which facilitates the application of the coating metal. The tank 38, at the left, contains the protective metal coating in molten form; this coating metal is preferably an alloy of lead and tin.

The tubing passes through all of the tanks at some distance above the level of the contents of the tanks and in the end walls of the tanks any suitable anti-friction devices (not shown), may be provided if desired, so that the tubing will pass freely through such walls.

In order to bring the liquids into contact with the tubing, pumps 40, 66 and 74 are utilized. The tubing T passes through pipes 48, 64 and 72, which are kept full of liquid by the pumps.

The action of the acid in cleaning the tubing is aided by an electrolytic process which is the reverse of the process ordinarily used in electroplating.

CONTINUOUS HOT DIP GALVANIZING OF STRIP

△ U. S. 2,875,096, issued Feb. 24 1959 to William L. Diebel and Henry S. Bell, assigned to Wheeling Steel Corp., relates to the continuous hot dip galvanizing of metal strip at high speed.

As continuous line speeds have increased during the past decade or so, great difficulty has been experienced in producing by continuous hot dip galvanizing galvanized strip of uniform optimum quality. The increased speed of the strip produces a strong tendency of the strip to carry with it an excessive quantity of spelter as the strip emerges from the bath of molten spelter and there is also a tendency for the coating on the galvanized strip to be relatively thick near the edges of the strip and relatively thin near the center of the strip.

It is possible by the use of grooved exit or coating rolls to counteract to some extent the above mentioned tendencies, but for the higher speeds which are now commercial, grooved exit rolls do not adequately serve the purpose.

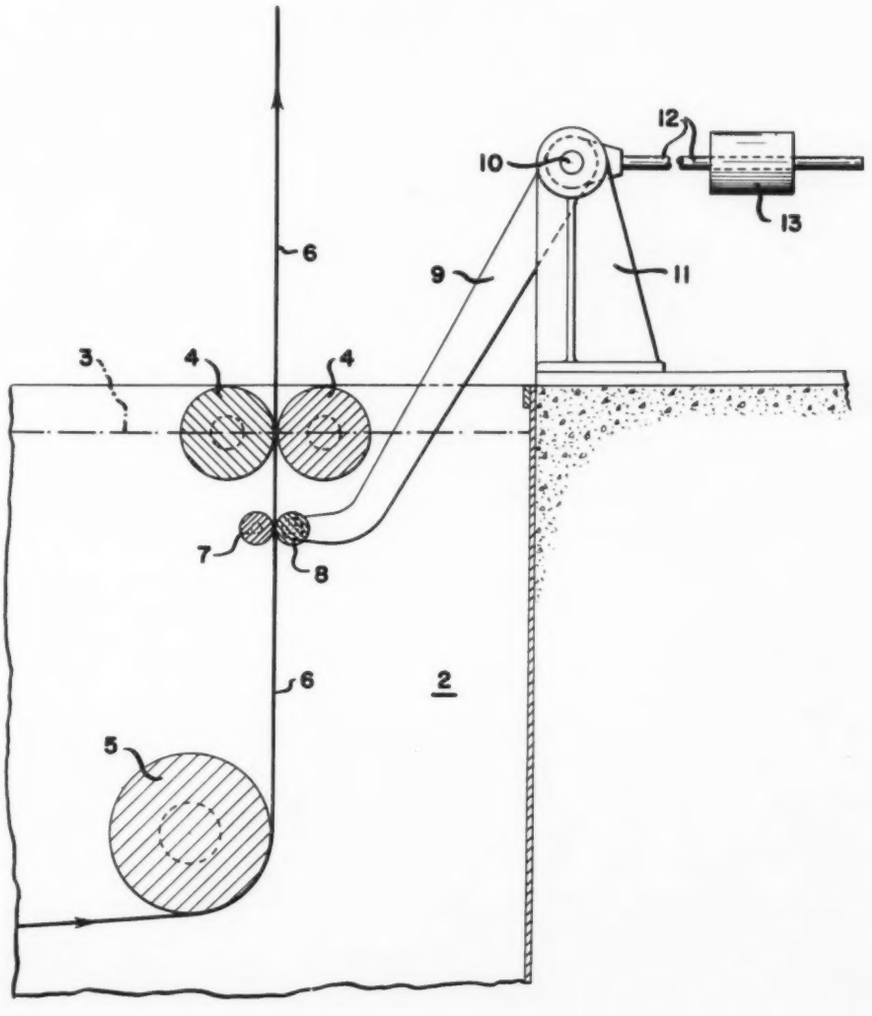
A factor which causes difficulty is the capillary attraction of the strip for the spelter. The exit rolls will break down the capillary attraction to a certain extent but their ability to do so is lessened as the strip speed and coating thickness increase. It has been found desirable to provide means engaging the strip in the molten spelter bath before the strip reaches the exit rolls to inhibit the tendency of spelter to cling to the strip, or, in other words, to break down the capillary attraction of the strip for the spelter.

As shown in Figure 5, the strip enters the galvanizing pot in conventional manner and passes through the molten spelter and about a guide roll 5 rotatably mounted below the surface of the spelter the strip passing vertically upwardly from the guide roll 5 between the exit rolls 4 as shown.

Opposed capillarity reducing rolls 7 and 8 engage the strip at opposite faces as shown. The capillarity reducing rolls 7 and 8 have faces resistant to wetting by molten spelter and are resiliently urged toward the strip. In the form shown, the roll 7 is mounted for rotation about a fixed axis and the roll 8 is resiliently pressed toward the roll 7. The roll 8 is rotatably mounted in a pivoted mounting structure 9 which is pivoted at 10 to a stationarily mounted bracket 11. Connected with the mounting structure 9 is an outwardly extending arm 12 carrying a weight 13 which is adjustably positionable along the arm. The structure 9, the arm 12 and the weight 13 are to all intents and purposes unitary and the weight may be adjusted along the arm as desired to resiliently press the roll 8 toward the roll 7 with the desired force. The rolls 7 and 8 are both freely rotatable and are turned by the movement of the strip in contact therewith.

The rolls 7 and 8 are so positioned relatively to the exit rolls 4 that substantial capillary attraction of the spelter to the strip cannot be set up between the rolls 7 and 8 and

Figure 5



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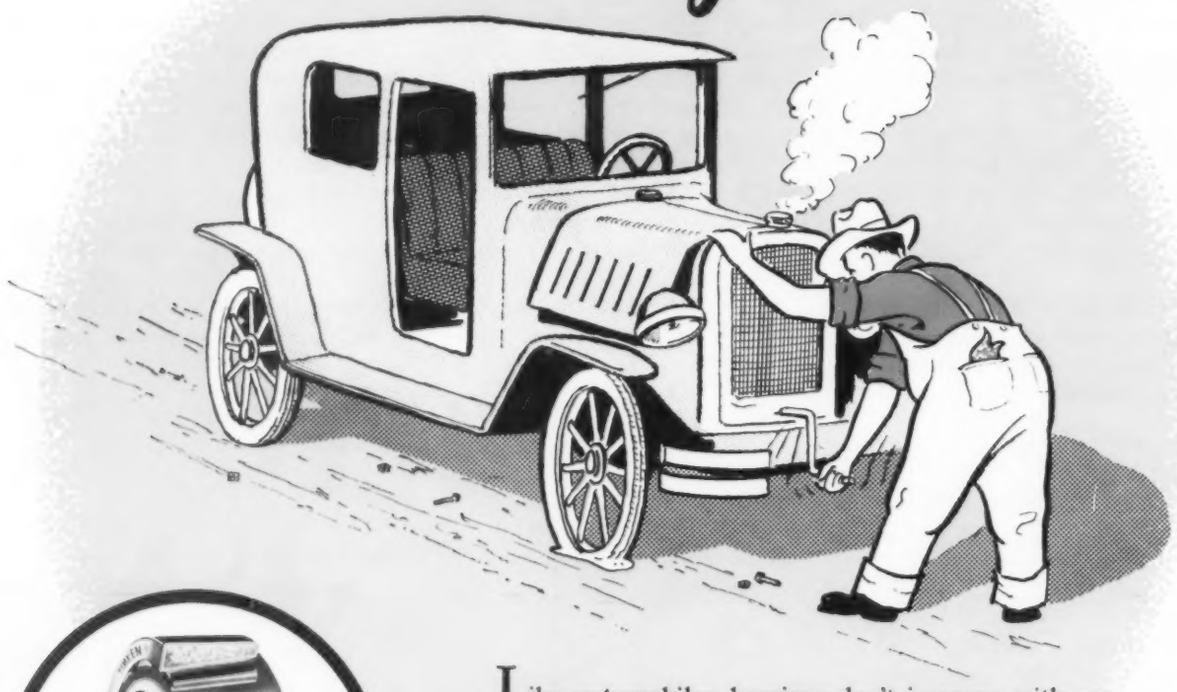

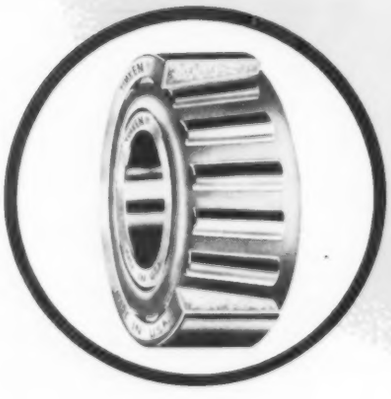

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the rolls 4. The rolls 7 and 8 reduce or break the capillary attraction of the spelter for the strip and thus co-operate with the exit rolls 4 in controlling the application of the spelter to the strip.

METHOD FOR STIRRING METAL BATHS

△ U. S. 2,875,036, issued Feb. 24, 1959 to Bo M. S. Kalling, assigned to Stora Kopparbergs Bergslags Aktiebolag, describes a method for the refining of metal melts in which the melt is more relative to the wall of the vessel.

The method is characterized in that the reaction vessel containing the metal melt is moved without rotation along a circular path, so that the metal melt moves circularly within the vessel.

As shown in Figure 6, the apparatus comprises a table 1, adapted to support a furnace, ladle or other vessel 7, containing the bath which

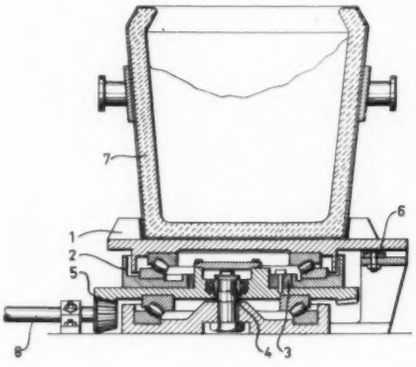

Figure 6

is to be treated. The table is supported on a disk 2, which in turn is adjustable with respect to a lower table 5 by means of an adjustable eccentric ring 3. The table 5 is rotatable around a fixed axis 4 and arranged to be driven at the desired speed from a shaft 8. The upper table 1, which supports the vessel 7, is simultaneously guided at one point 6 in order to prevent the table 1 from rotating with respect to the axis 4.

SMELTING FINELY DIVIDED IRON ORE

△ U. S. 2,876,092 and 2,876,093, issued March 3, 1959 to William E. Greenawalt, describe processes for smelting finely divided iron ore.

As shown in Figure 7, the finely ground ore concentrate is dried in 1, and delivered into the hopper 2, from which it is fed in continuous subdivided streams into the highly heated oxidizing atmosphere of the upper section of the melting furnace 3 in the upper part of the vertical shaft, then through the highly heated reducing atmosphere in the lower section of the melting furnace 3 to melt it. The molten ore is then delivered from the melting furnace 3, separated from the melting furnace gas, into a highly heated column of carbon, in lump form, in the smelting furnace 4 in the lower part of the vertical shaft, where the smelting is completed to produce pig iron and slag. The slag flows out through the slag hole 5, and the iron through the tap hole 6.

Fluid heating agents are introduced into the oxidizing section of the melting furnace by means of the burners 7, and fluid reducing agents through the injectors 8. Air is delivered into the carbon in the smelting furnace through the tuyeres 9, and carbon is delivered into the smelting furnace through the feeders

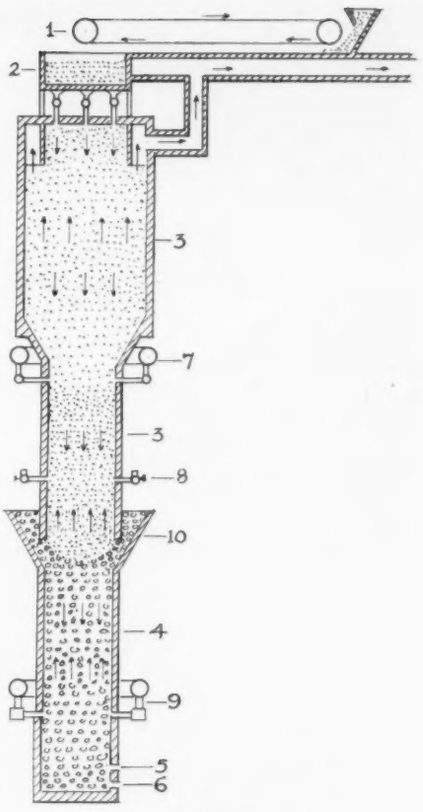

Figure 7

10, in between the melting and smelting furnaces.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or assignee
2,875,035	2/24/59	Elimination of pyrophorism in articles produced from chemically reduced iron	Republic Steel Corp.
2,875,039	2/24/59	Leaching iron from titaniferous ores	Columbia-Southern Chemical Corp.
2,875,042	2/24/59	High temperature alloy steel	The Carpenter Steel Co.
2,875,109	2/24/59	Isothermal treatment of alloys after casting	The Eimco Corp.
2,875,113	2/24/59	Decarburization of silicon steel in a wet gas atmosphere	General Electric Co.
2,875,261	2/24/59	Magnetomotive agitator for molten metal baths	Swindell-Dressler Corp.
2,875,483	3/3/59	Apparatus for solidifying steel ingots	Peter J. Hughes
2,875,653	3/3/59	Device for rolling with repeaters in open mills	Wilhelm Langballe, et al.
2,876,091	3/3/59	Reduction of iron oxide in fluidized beds	United States Steel Corp.
2,876,095	3/3/59	Manufacture of gun barrels	Republic Steel Corp.
2,876,096	3/3/59	Nonmagnetic austenitic steel	Crucible Steel Co. of America
2,876,761	3/10/59	Helicoidal stone-sawing wire	United States Steel Corp.
2,876,864	3/10/59	Separation of dust from sinter waste gas	Metallgesellschaft Aktiengesellschaft, A.G.
2,877,009	3/10/59	Adjustable form for repairing refractory around a taphole	United States Steel Corp.
2,877,108	3/10/59	Reduction of iron ore	R-N Corp.
2,877,111	3/10/59	Production of nodular cast iron	Union Carbide Corp.
2,877,146	3/10/59	Pickling process	Puriron Chemicals, Inc.
2,877,163	3/10/59	Production of metallurgical coke	Charbonnages de France
2,877,281	3/10/59	Electric furnace regulators	Shawinigan Chemicals, Ltd.
2,877,821	3/17/59	Coiling machine	E. W. Bliss Co.
2,878,005	3/17/59	Coil support for box annealing furnace	United States Steel Corp.
2,878,009	3/17/59	Sinter cooling machines	William M. Bailey Co.
2,878,150	3/17/59	Forging chromium manganese austenitic steels	United States Steel Corp.
2,878,170	3/17/59	Sealing means for the joint of a coke oven door	Pierre E. H. Forsans

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Wherever you need general utility packings that are easy to handle, highly heat resistant

Throughout the iron and steel industries, the list of uses for Johns-Manville Asbestos Wick and Rope is constantly growing. These soft, resilient, heat-resisting materials are widely employed for general packing, gasketing and caulking applications.

In coke ovens, both are used to caulk around the doors to prevent the escape of gases. Asbestos Rope (Style 4200) also serves as expansion joint material in the brickwork.

Only a few of the many applications for Asbestos Wick (Style 4202) can be given here. It seals hot metal in the ingot mould, around the top and between the mould and the stool. It gives protection from burning to water hoses that cool Open Hearth doors. It serves as a seal between the cope and drag on moulding flasks. It is used to wipe excess coating from wires after passing through the galvanizing bath.

Styles 4200 and 4202 are made from pure asbestos fibre carefully controlled for quality at Johns-Manville's own mine and mill (largest in the world). Asbestos Rope is formed by twisting together two or more strands of Wick to obtain the desired thickness. For further information, call your local J-M distributor or write Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

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Micro Lustre

VACUUM MELTED FINISHING ROLLS

A switch from air-melted rolls to MidVac Rolls reduced regrinding and refinishing time by as much as 50% in one large steel mill. Now, operators can refinish rolls quicker to a higher polish which produces finer sheets.

MidVac Rolls are made with consumable electrode vacuum melted MidVac Steels. These super-alloy steels produce a Micro-Lustre finish made possible by super uniformity of fine grain structure, maximum freedom of defects and non-metallic inclusions. MidVac Micro-Lustre Rolls assure rolling free from surface imperfections . . . quicker regrinding . . . and give longer trouble-free service between grinds.

MidVac Rolls are being used throughout the nation for rolling stainless steel, aluminum, foil, brass and precious metals. Midvale-Heppenstall also make forged rolls of any size, for any purpose required in the rolling of steel, aluminum, copper, brass and other metals . . . as well as paper, plastics and rubber. Write for complete data on these new Micro-Lustre Rolls.

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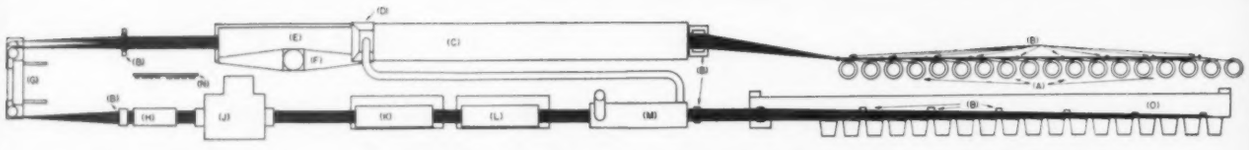
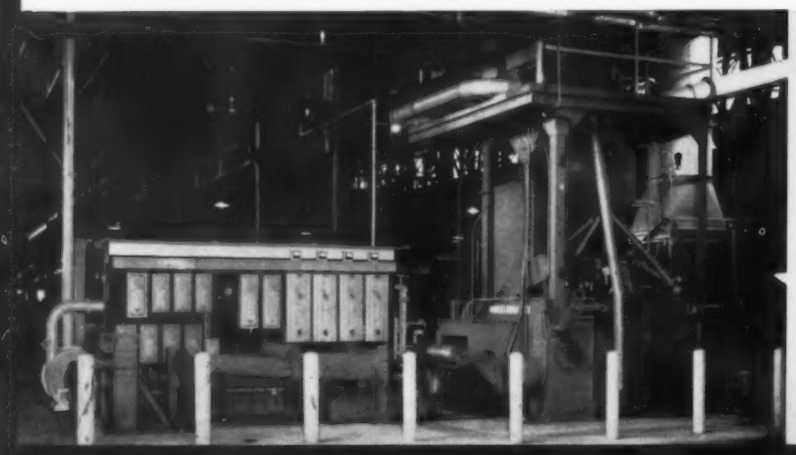
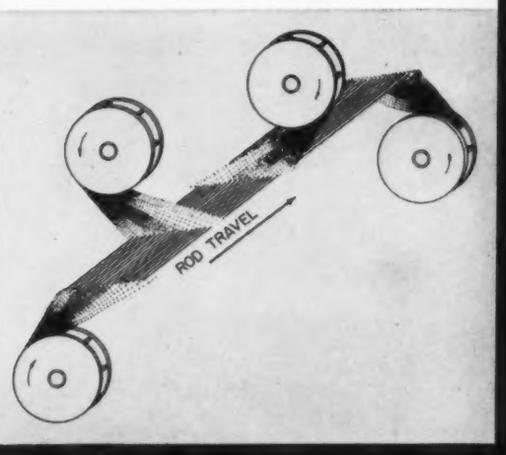
A NEW TWIST TO WIRE MAKING



A. PAY-OFF SWIFTS
B. ROD GUIDES
C. FURNACE
D. COLLECTING HOOD
E. LEAD BATH
F. EXHAUST HOOD
G. TURN AROUND
H. WATER COOLING BATH
J. WHEELABRATOR MACHINE
K. BORAX COATING BATH
L. LIME COATING BATH
M. DRYER
N. CONTROL PANEL
O. TAKE-UP FRAME





ROEBLING continuous wire production based on WHEELABRATOR® blast cleaning

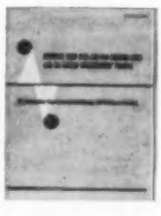
Continuous patenting, cleaning and coating of steel wire adds up to more efficient operation at lower cost, for John A. Roebling's Sons Corp.

The new processing line, installed at the Roebling mill, incorporates Wheelabrator airless blast cleaning as a key step in the operation. Wire now is patented and cleaned in one continuous operation, with a resultant decrease in labor cost.

Eighteen strands of steel wire pass simultaneously through the muffle furnace, lead quenching bath, Wheelabrator blast cleaning machine, coating baths, drying ovens, and thence to the take-up frame, in a compact operation occupying an area of 250 ft. long and 30 ft. wide. Normal production rate is about 6,000 pounds per hour. Speeds through the blast cleaning unit vary with the gauge of wire, with .250" diameter rod running at 34 fpm.

Wheelabrator mechanical cleaning eliminates the costly problems of acid disposal, and maintenance of acid pickling equipment. By promoting efficient "straight-line" production, it minimizes handling costs. The combined effect of cleaning and labor savings is a considerable reduction in the patenting and cleaning cost.

Write for Bulletin 148-D, illustrating use of the Wheelabrator process for producing finished wire from hot rolled rod in one continuous operation.



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396 South Byrkit Street **Mishawaka, Indiana**
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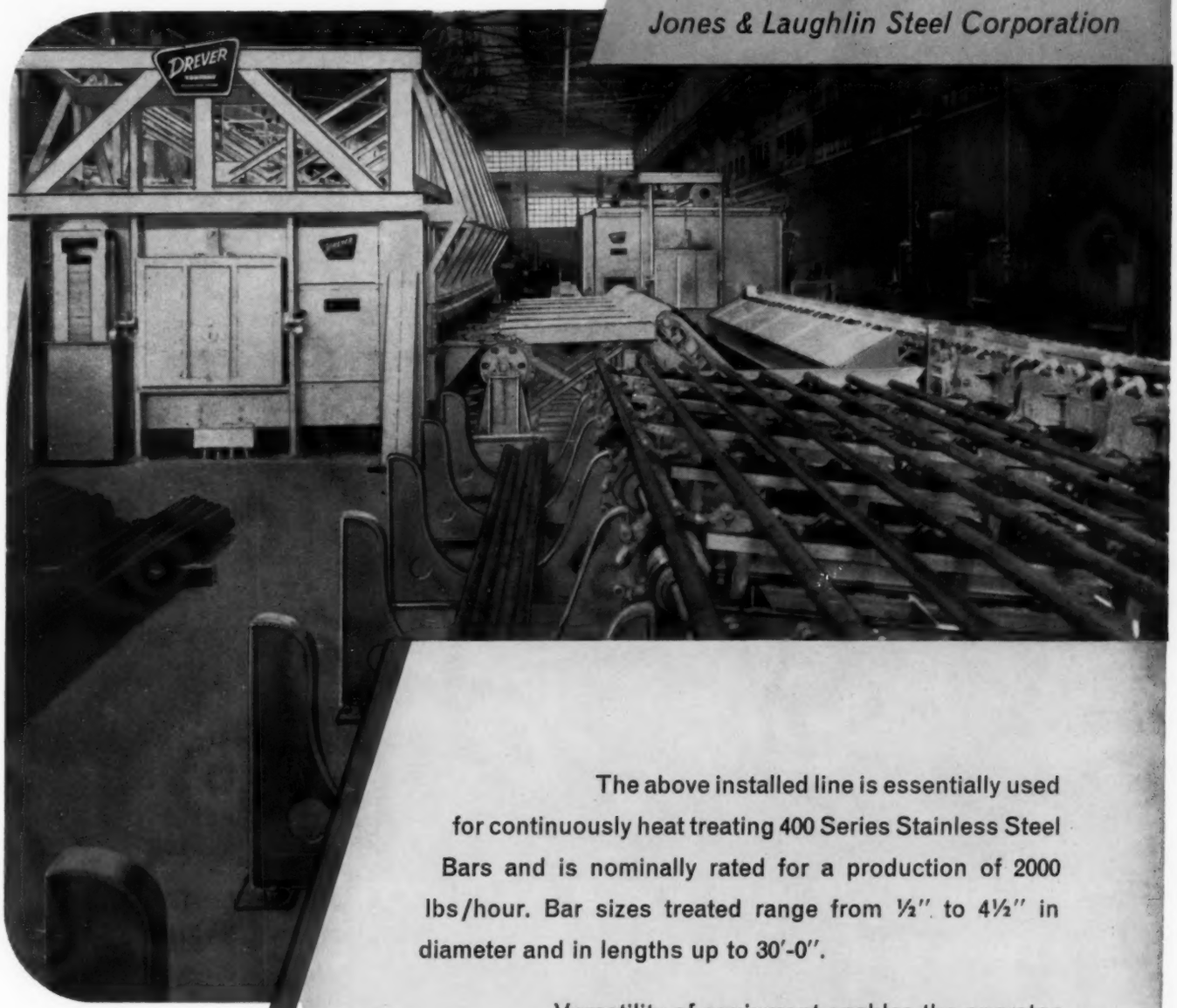
WORLD'S LARGEST MANUFACTURERS OF AIRLESS BLAST CLEANING EQUIPMENT AND STEEL ABRASIVES

DREVER

Continuous BAR HEATING LINE

at the Detroit Plant of the Stainless and Strip Division of Jones & Laughlin Steel Corporation



The above installed line is essentially used for continuously heat treating 400 Series Stainless Steel Bars and is nominally rated for a production of 2000 lbs/hour. Bar sizes treated range from ½" to 4½" in diameter and in lengths up to 30'-0".

Versatility of equipment enables the operator to automatically change from a normalizing cycle to a heat treat cycle, including quench and draw facilities, without the interruption of the continuous operation.

We welcome your inquiry on your wire, rod, bar, sheet, plate and strip heating problems.

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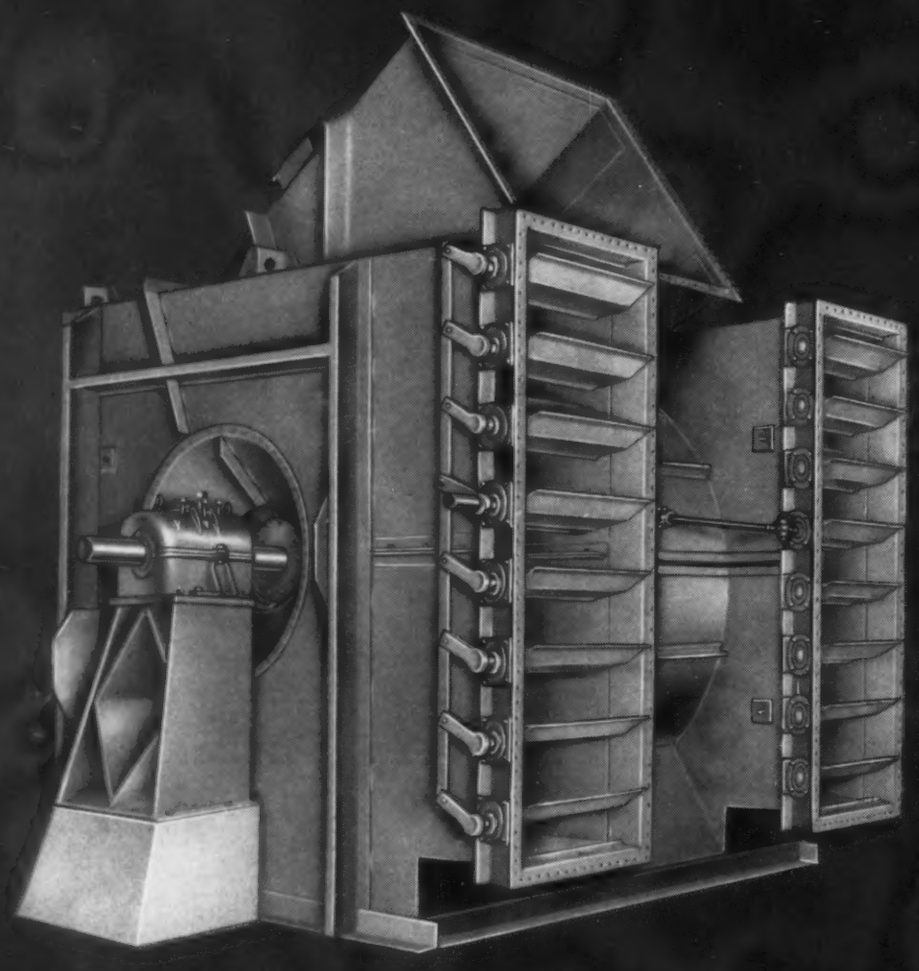

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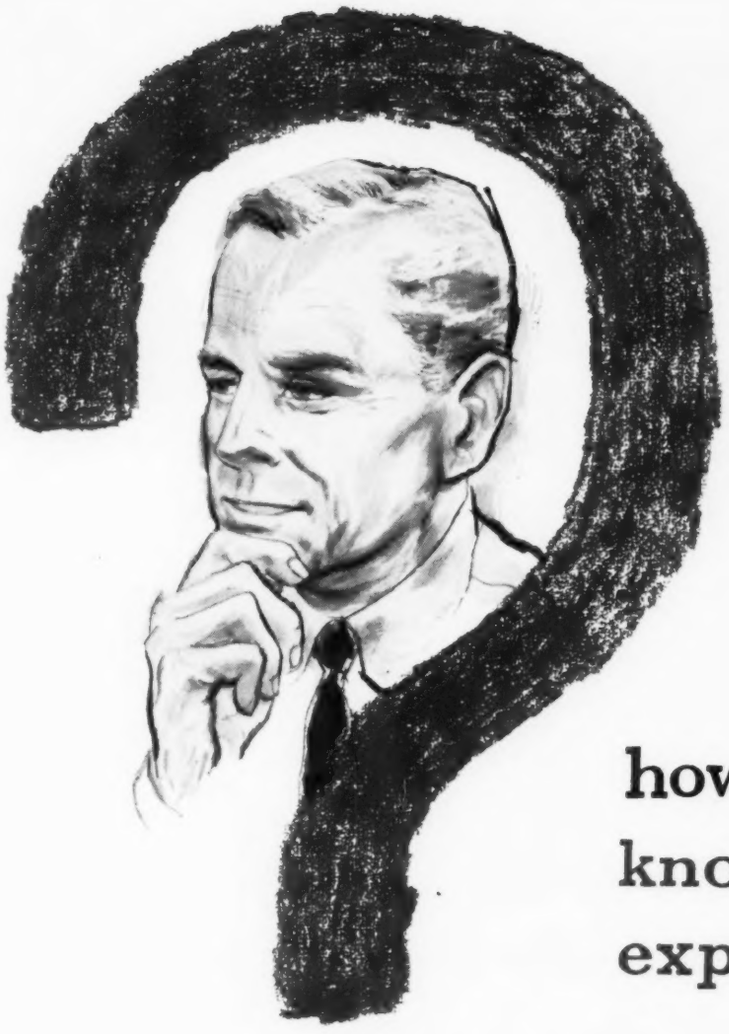

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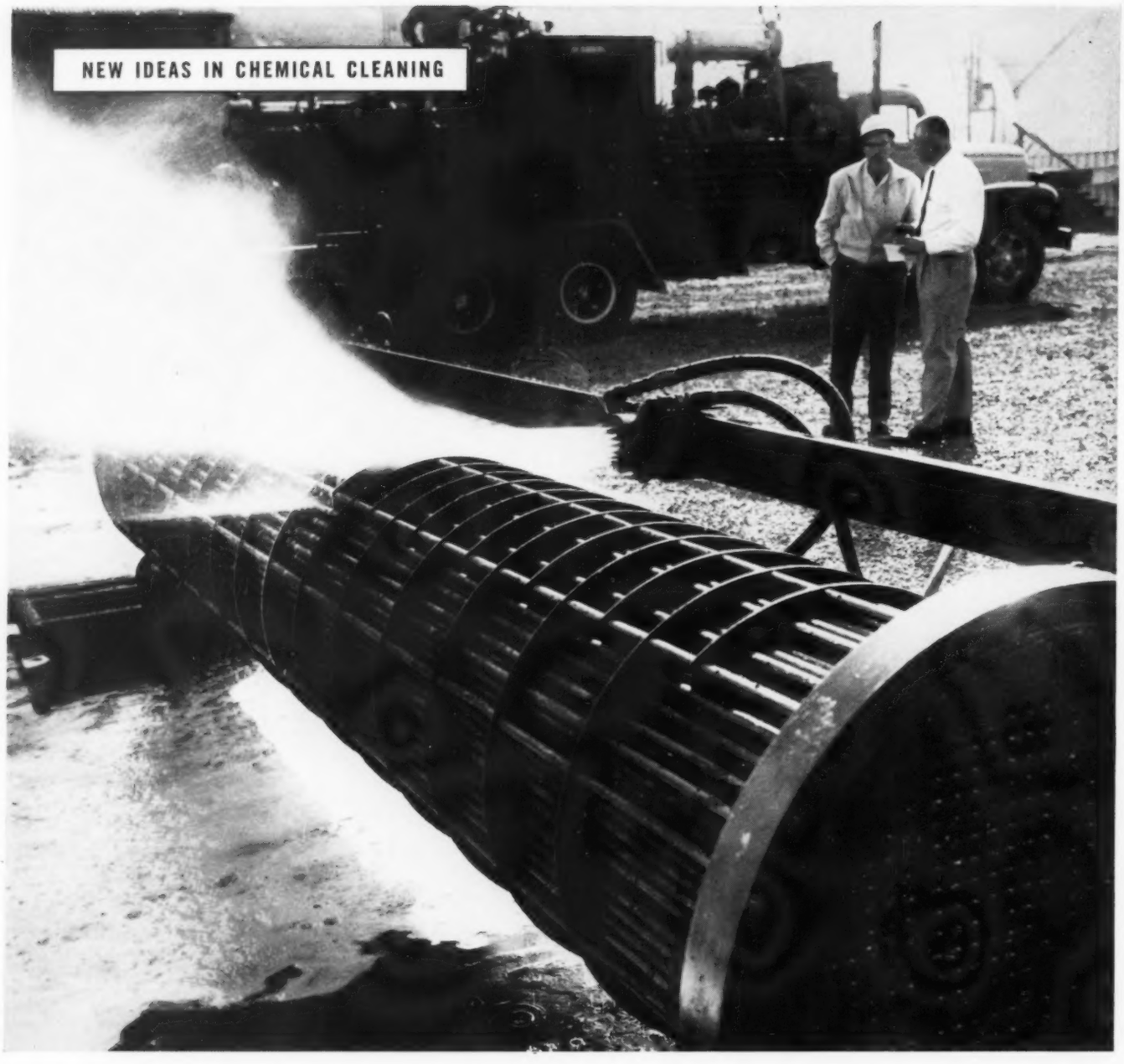


New Jetting Tool To Clean Tube Bundles Saves Thousands Of Dollars

The new high-pressure hydraulic tool, shown above, is currently saving thousands of dollars for companies in the refining, chemical, and petrochemical industries. It is the jetting tool developed by Dowell to remove deposits from heat exchanger tube bundles.

Previous methods of cleaning these bundles have been costly, time-consuming and often inadequate. Many times bundles had to be replaced completely because of the lack of a suitable cleaning method.

This new Dowell tool has a remarkable record of thorough, fast cleaning. For example, a slurry reboiler exchanger bundle, three feet in diameter and 16 feet long, was fouled with deposits of coke and asphalt. After being jetted from only one side, the bundle was thoroughly clean. Time required: less than one hour.

The tool holds the bundle in place for cleaning and has flanged rollers for rotation. The jet-head is manipulated automatically so that all tube spaces are covered. The jetted liquid can be either water or chemical solvents.

This high-velocity jetting device is another example of the new ideas Dowell continues to offer in chemical cleaning to help you cut your costs. Whatever the cleaning problem in your plant, call Dowell for an engineered recommendation. Dowell — the largest, the oldest, the most experienced chemical cleaning service — Tulsa 1, Oklahoma; and 165 stations and offices in major industrial centers.

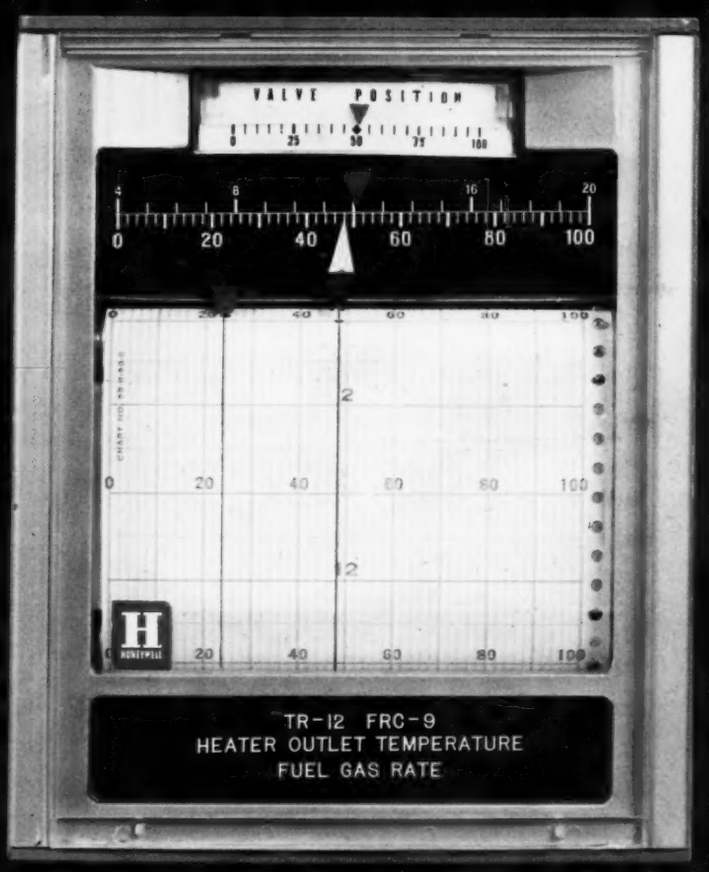
Chemical cleaning service for all industry DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

Here it is!

Honeywell's new *ElectriK Tel-O-Set** system

...the only true two-wire system for electric process control!



No line power connections in the field. The *ElectriK Tel-O-Set* system requires no external power at any field-mounted device and uses only two wires between it and the control room. These two wires form a series circuit that carries the measurement or control signal as well as the system's power. The only line power connection is made at the receiver.

Two-wire transmission sharply reduces installation costs. Add this to the fact that the *ElectriK Tel-O-Set* system's d-c transmission eliminates the need for shielding the wires, and you have the simplest, most economical installation possible.

*Trade name, Minneapolis-Honeywell Regulator Company

HONEYWELL

COMPARE *ElectriK Tel-O-Set* WITH ANY OTHER ELECTRIC CONTROL SYSTEM!

Here it is!

the new *ElectriK Tel-O-Set* system

. . . newest advance in industrial process control

A complete, integrated line . . .

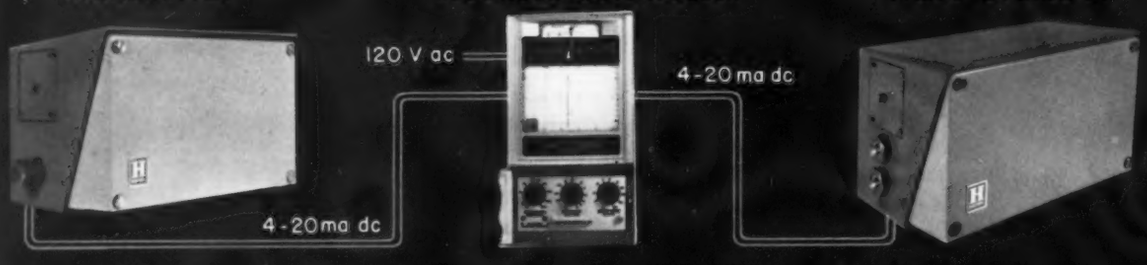
Control *any* industrial process with the *ElectriK Tel-O-Set* system. It has been designed as a complete system, rather than as a collection of individual instruments. The line consists of 22 major units which permit local and centralized data presentation, adjustable cascade control, ratio control and many other auxiliary functions. *ElectriK Tel-O-Set* transducers make the line completely compatible with your present pneumatic instruments.

. . . built for industry

Die-cast aluminum cases and stainless steel components are used throughout the line to withstand the rough handling and demanding environments of industrial applications. Standardized components, together with extensive use of quick-connect and plug-in design, mean ready interchangeability of parts, reduced spare parts inventory, easy maintenance. The modular, or "building block" concept is employed throughout for maximum flexibility.

. . . this is how it works

The basic *ElectriK Tel-O-Set* system consists of a transmitter, receiver, controller and final control element. The transmitter measures any process variable, translates it into a standard 4 to 20 milliampere direct current signal, and transmits to the receiver through a pair of copper wires. The receiver indicates or records the signal in terms of the actual value of the process variable, compares it with a pre-determined set-point, and sends the difference to the controller as an error signal. The controller then converts this into a corrective 4-20 milliampere output to operate the control valve—again transmitting over a single pair of copper wires.



All process and external electric connections to *ElectriK Tel-O-Set* field-mounted transmitters are entirely isolated from inside the case . . . to permit installation without the need for instrument department supervision.

All receivers, fron single-point indicator without control to two-pen ratio-cascade control station, are housed in the same case and all use the same panel cutout of 5½ x 6 inches. Controllers can be mounted with adjustments in front or back of panel.

All *ElectriK Tel-O-Set* field-mounted units . . . whether transmitter, transducer, or valve actuator . . . operate at ambient temperatures of —40 to 150° F. They all work on the same force-balance principle and use many similar components.

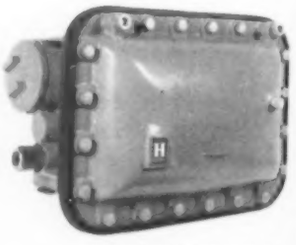
CHOICE OF THREE CASES

For field-mounted *ElectriK Tel-O-Set* units: Weatherproof for Division 2 locations; relay rack for mounting four abreast in a 19-inch rack, and explosion-proof for Division 1 locations.

All are completely transistorized and have quick-connect electric and pneumatic plugs.

Weatherproof

Relay rack



Explosion-proof

SYSTEM COMPONENTS

TRANSMITTERS
Process pressure to current (PP/I)
Differential pressure to current (Δ P/I)
Millivolt to current (MV/I)

RECORDERS
Single or two-pen recorders. Single or two-pen recording controllers with control, including simple cascade, on one pen. Two-pen recording controllers with ratio or cascade control on one pen.

INDICATORS
One pointer, with or without control
Milliammeter, with or without manual loading

CONTROLLERS
Two mode and three mode

FINAL CONTROL ELEMENTS
Current to pressure (I/P) valve operator
Electro-pneumatic positioner
Electro-hydraulic actuator

TRANSDUCERS
P/I: 3-15 psi to 4-20 ma dc
I/P: 4-20 ma to 3-15 psi
I/F: 4-20 ma dc to frequency
F/I: frequency to 4-20 ma dc

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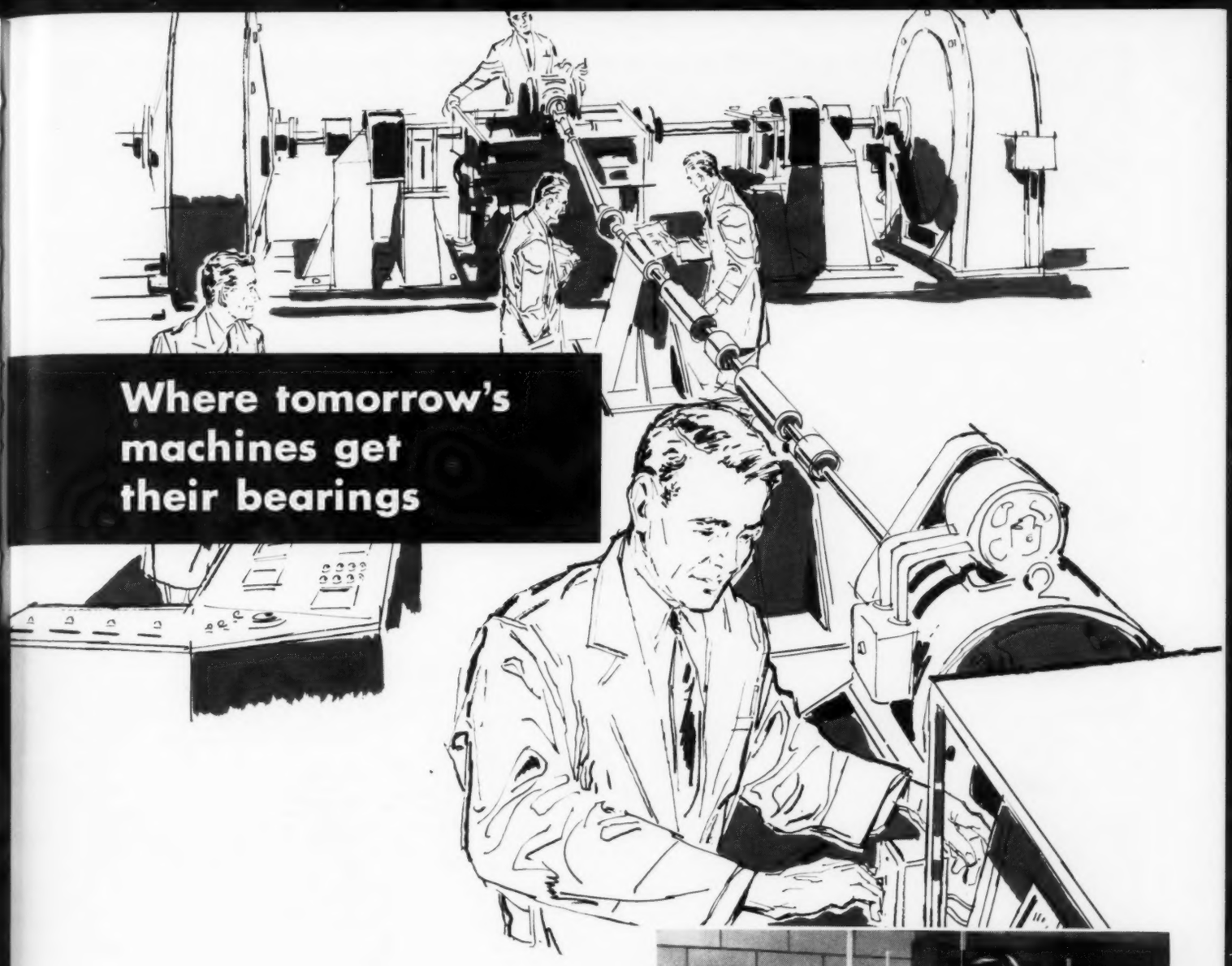

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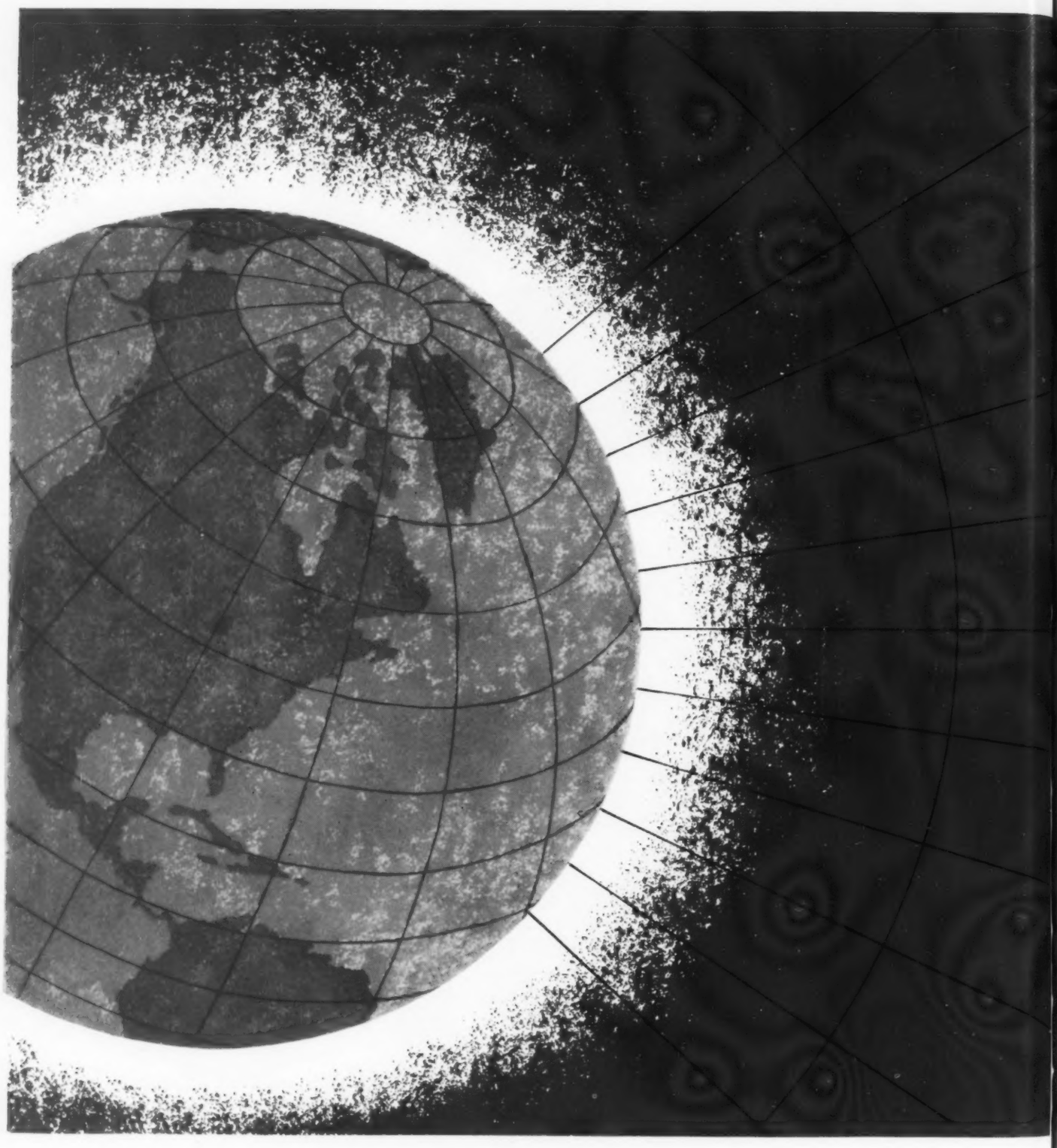

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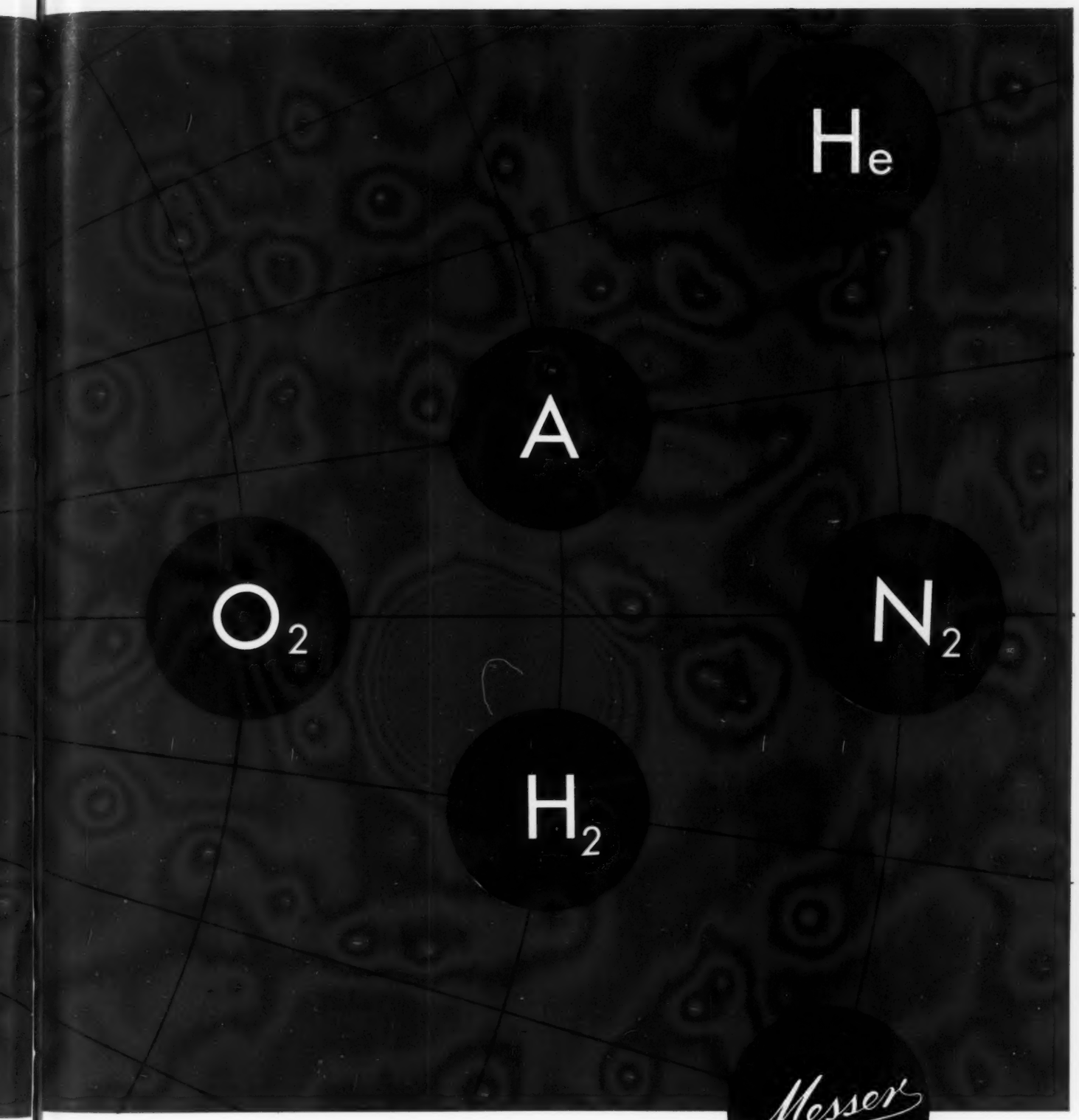
"THERE IS NO SUBSTITUTE



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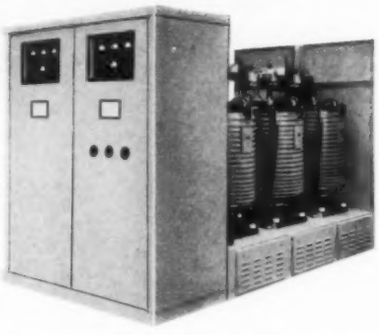
SIEMENS

18-stand continuous medium-strip rolling mill controlled by static convertors



Excitron convertor set with 6 single-anode tanks for d.c. voltages up to approx. 1600 V and continuous currents up to approx. 3,500 A (r.m.s.), maximum currents up to approx. 9,000 A (r.m.s.)
Weight of a mercury-arc unit approx. 440 lb (200 kg)
Weight of a complete convertor set approx. 6,600 lb (3,000 kg).
Area of base 6 ft × 11 ft (1.8 × 3.3m)

You are making a good buy

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Foreign Digests

Complete translations from which these condensations were prepared are available from Henry Brutcher, P.O. Box 157, Altadena, Calif., to whom all correspondence should be addressed.

"STIRRING OF OPEN-HEARTH STEEL BATHS WITH A ROTATING MAGNETIC FIELD"

by G. A. OSTROUMOV (Translation No. 4511 from Stal', Vol. 18, 1958, No. 11)

△ MIXING of reacting substances is important for speeding up the processes involved in steelmaking. Since mechanical mixing in open-hearth furnaces is very difficult, it seems desirable to use in them, as in arc furnaces, a rotating magnetic field.

Electromagnetic mixing is complicated by the high furnace temperature, its large size and, in particular, the thickness of its walls, which makes it impossible to use an iron stator or a magnetic conductor of suitable design.

Magnetic mixing of steel requires the setting up of current-carrying conductors of the stator winding and the insertion of electrically insulating packings in the steel framework of the furnace.

The motion of the liquid metal should be turbulent, to get the greatest possible mixing and diffusion. The best result can be obtained by rotating the steel around a horizontal axis so that the lower layers replace the upper, and vice versa.

The root of the problem is the correct choice of the frequency of the a-c multiphase current for setting up the moving magnetic field. The lower the frequency, the deeper the eddy currents and the magnetic field penetrate into the conductor.

The characteristic depth is proportional to the square root of the ratio of the resistivity of the metal to the current frequency. It is therefore desirable to lower the frequency so as to increase the depth of action. However, because of the great convenience of using industrial three-phase current, calculations must be made for 50 cps, before going over to frequency transformation.

The framework of the furnace should be below the stator conductors. The rotor is the liquid steel; eddy currents form in it, as in the rotor of an asynchronous motor, interact with the moving magnetic field of the stator and set the bath in motion. The speed of this motion is determined by the density of the electrodynamic forces acting, the viscosity of the bath and the boundary conditions. The rate of movement of the liquid rotor is only a very small fraction of that of the magnetic field. It is impossible appreciably to improve this state of affairs, unless the stator could be brought up to the metal surface.

The stator winding should be embedded in the thickness of the hearth as close as possible to the bottom surface of the bath.

"AIR COOLING OF BOTTOM OF NO. 2 BLAST FURNACE"

by N. V. KREPYSHEV, Assistant Manager, Technical Department, Kuznetsk Metallurgical Combine (KMK). (Translation No. 4550 from Metallurg, Nov. 1958, No. 11)

△ IN 1938 a start was made on inserting thermocouples into the foundations of blast furnaces. First observations showed that the temperature of the foundation under the hearth reaches 1380 to 1470 F on the furnace axis. This temperature increases as the hearth erodes, and attains 1830 to 2010 F in the upper parts of the foundation. Ordinary concrete and its reinforcement lose their strength at such temperatures.

Polovchenko and Semikin suggested bottom cooling of hearths and reduction of hearth thickness. However, bottom cooling of hearths with plate cooling elements as proposed was not favored. New blast furnaces were built with the usual system of hearth cooling. An increase of hearth thickness to 0.7–0.8 of its diameter did not give any substantial protection from breakthroughs. The need for bottom cooling became obvious.

The blast furnaces at Kuznetsk were commissioned in 1932–34. The hearth was about 11.8 ft thick and was cooled with two rows of peripheral cooling plates which cooled approximately two-thirds of its height and did not extend to the bottom of the hearth.

In the first major repairs (1936–44), the iron remaining in the hearth was not removed. The peripheral part of the hearth was dismantled somewhat below the salamander, and relined with fireclay brick laid flat. On the surface of the salamander, to the design mark, at the top of the hearth, scrap rails and blooms were placed. The gaps between the rails, and between the new lining at the periphery and the solidified iron, were tightly packed with chrome iron ore.

Over ensuing years, hearths were rebuilt, following generally the conventional design. In 1953, at the time of a major overhaul, ampules containing radioisotopes were laid in the hearths. Measurement of the radioactivity of the iron gave an indication of the erosion of the hearth.

It was found that breakthroughs in 1953 were due not so much to the formation of deep pits in the hearths as to radial cracks running right through the foundation to its centerline, actually dividing it into four parts.

When No. 2 furnace was rebuilt in 1956, bottom air cooling of the hearth was provided by four banks of steel tubes (nine per bank) laid on the surface of the concrete and brought out through holes punched in the wall of the notch, after which the holes were concreted up. The two central banks had tubes of $5\frac{3}{4}$ in. inside diameter, while the two outer banks had tubes of $3\frac{5}{8}$ in. inside diameter. They were laid with a variable pitch, increasing toward the periphery.

After the tubes had been positioned, the spaces between them were filled with cement mortar, and a carbon composition was rammed in from above. Thermocouples were inserted below the tubes.

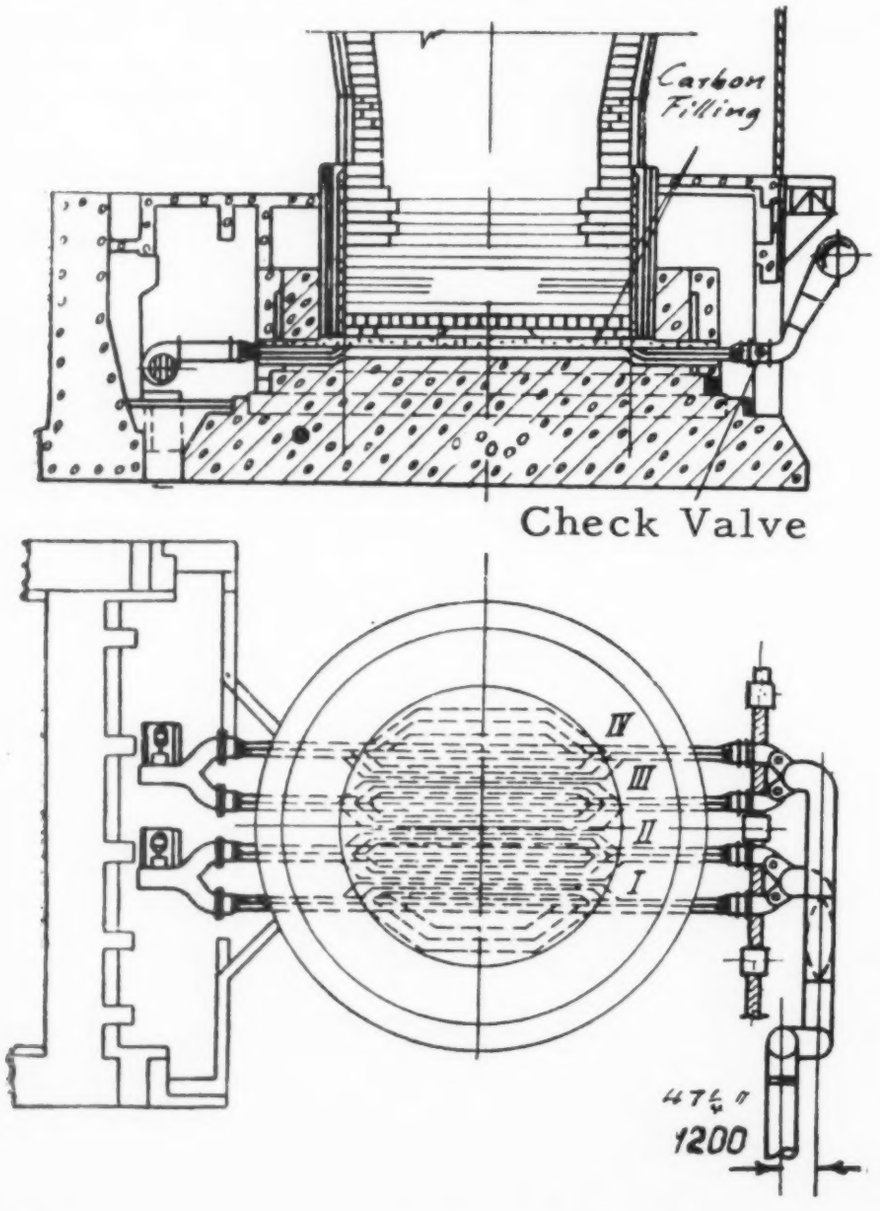
Two blowers, each of 780,000 cu ft per hr capacity were used to deliver air at 6 in. water gage. Each blower was attached to two banks of tubes.

No. 2 blast furnace was blown in on September 8, 1956. Bottom air cooling for the hearth started in the first days of October, 1956.

Air flow runs 20,000 to 22,000 cfm for the entire hearth, with heavier flows through the tubes toward the center of the furnace. Air temperature increases some 10 to 15 F. The rate of heat removal in May–August, 1958, was 276,800 Btu per hour or 7.5 Btu per minute per sq ft. The rate of heat withdrawal from the peripheral cooling plates on the lateral surface of the hearth in May 1958 was 8.9 Btu per min per sq ft.

There is no doubt that the hearth in No. 2 furnace will last well, since there is no danger of thermal cracks developing in the hearth and foundation, thanks to the low and uniform temperature in these parts.

Figure 1 — Air cooling below the hearth bottom of No. 2 furnace.



SUMMARY

Bottom cooling of a blast furnace hearth with air considerably lowers the temperature in the bottom of the hearth and the foundation stump, and makes it more uniform.

The small gradient of temperature in the air indicates that less powerful blowers could be used.

The comparatively rapid disintegration of the upper courses of brick in the hearth, as indicated by rapid rise of thermocouple readings in the early months of the campaign, indicate that the thickness of the hearth should be much reduced when bottom cooling is applied to it.

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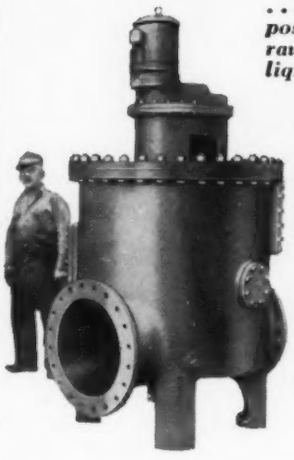

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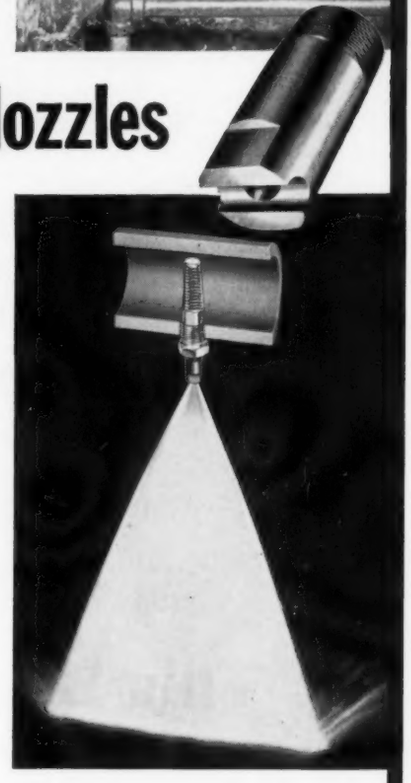

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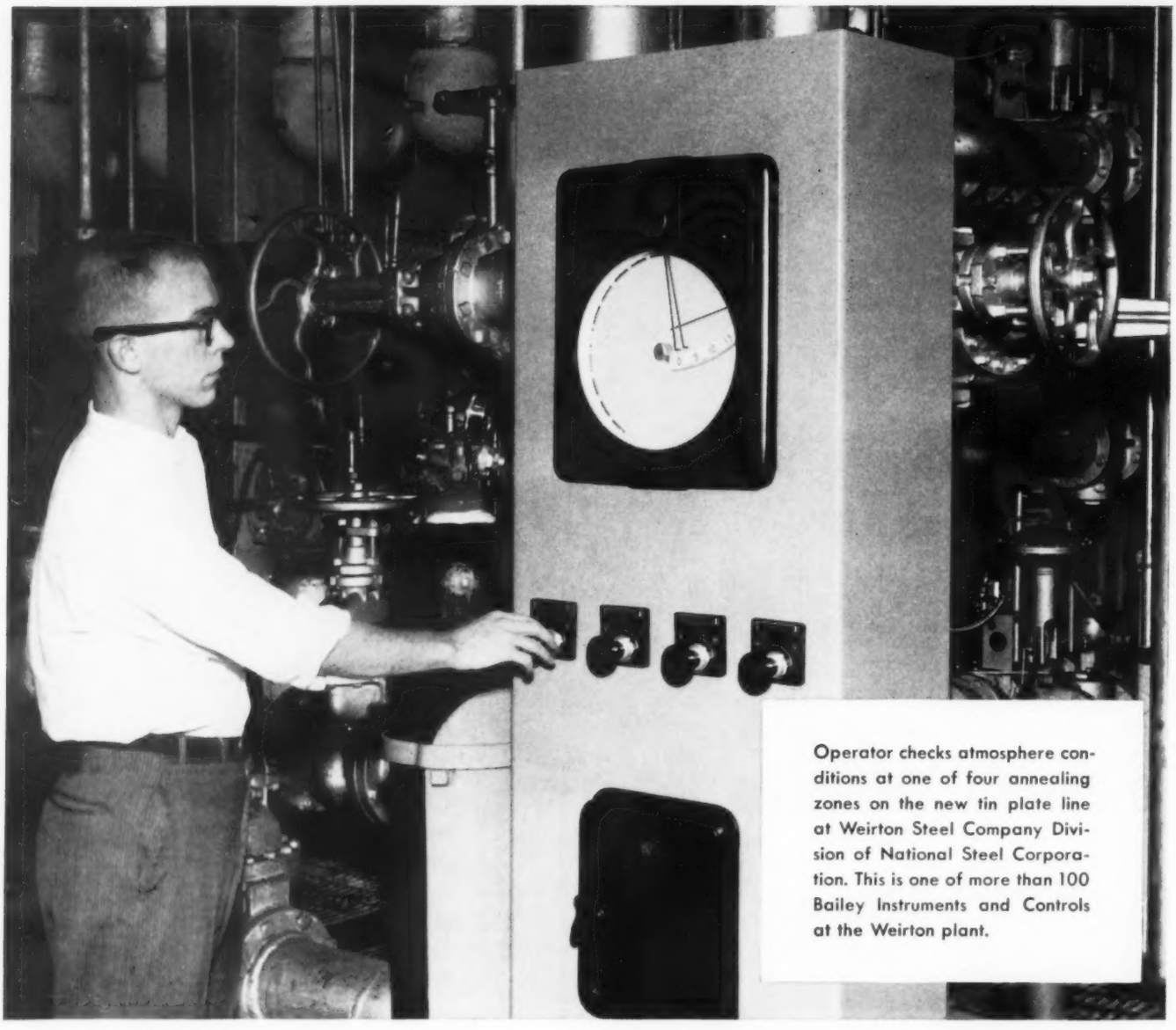

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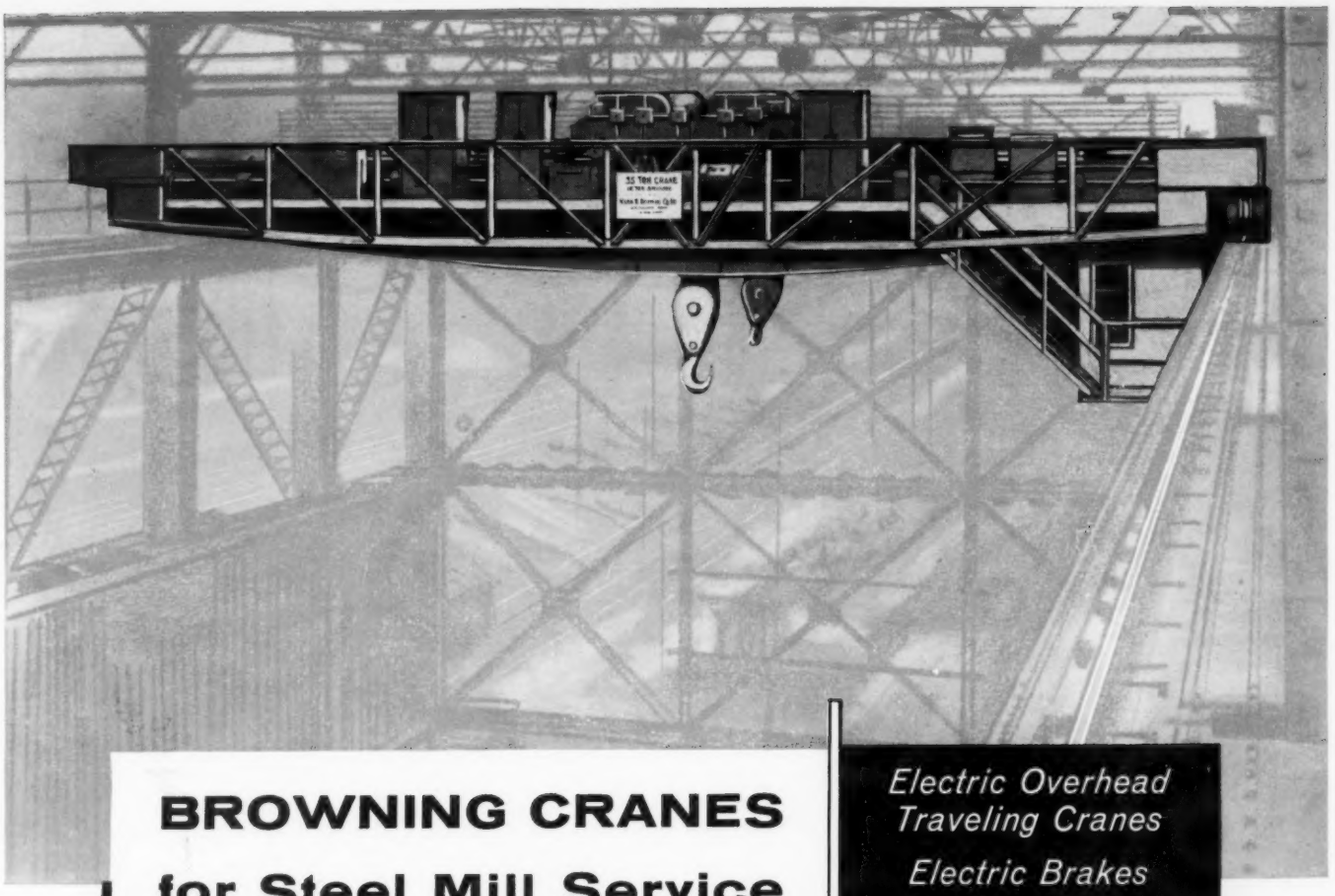

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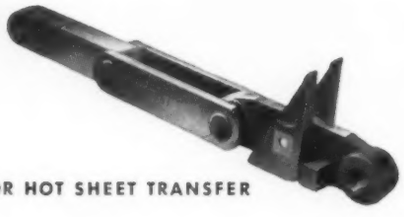

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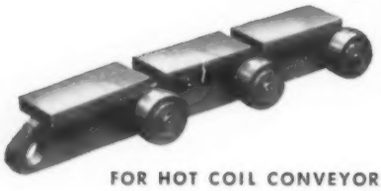

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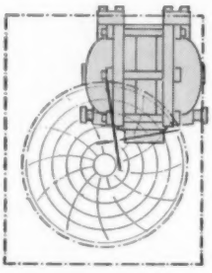

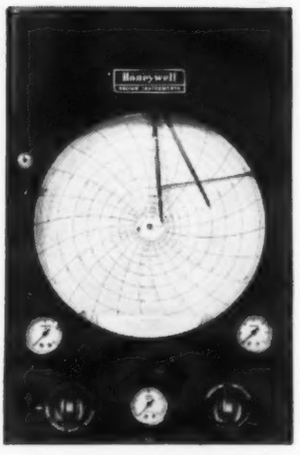

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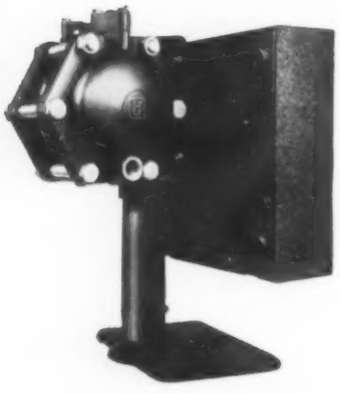

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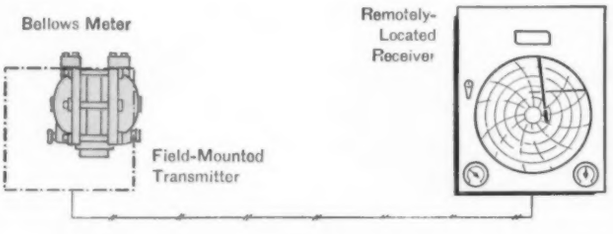

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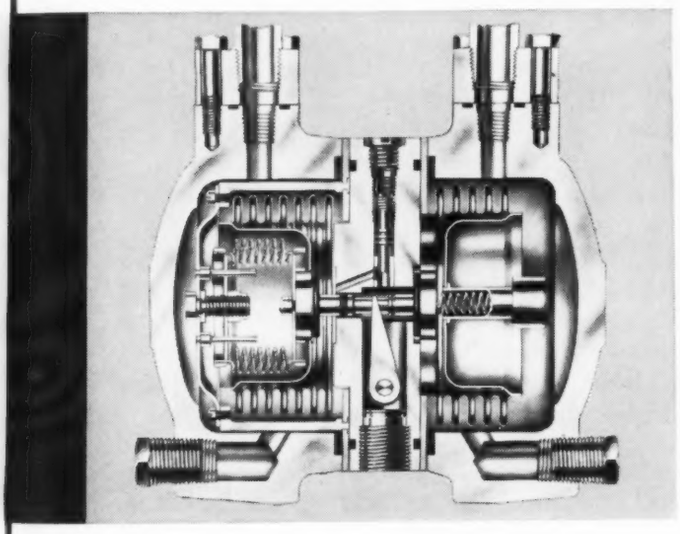

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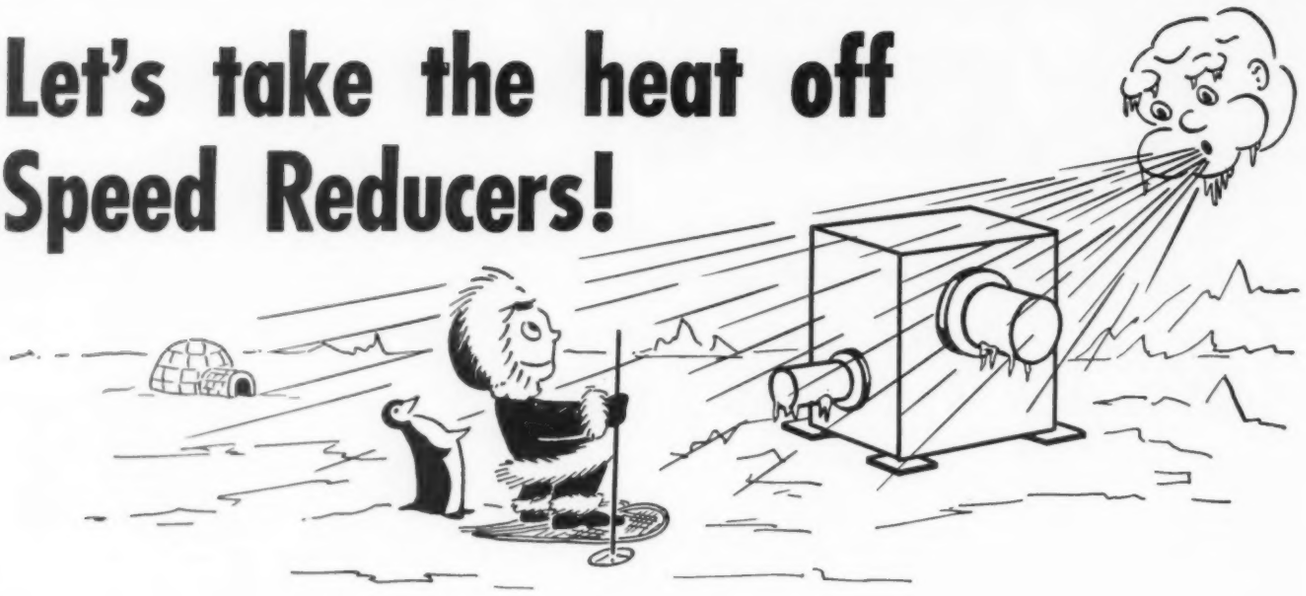

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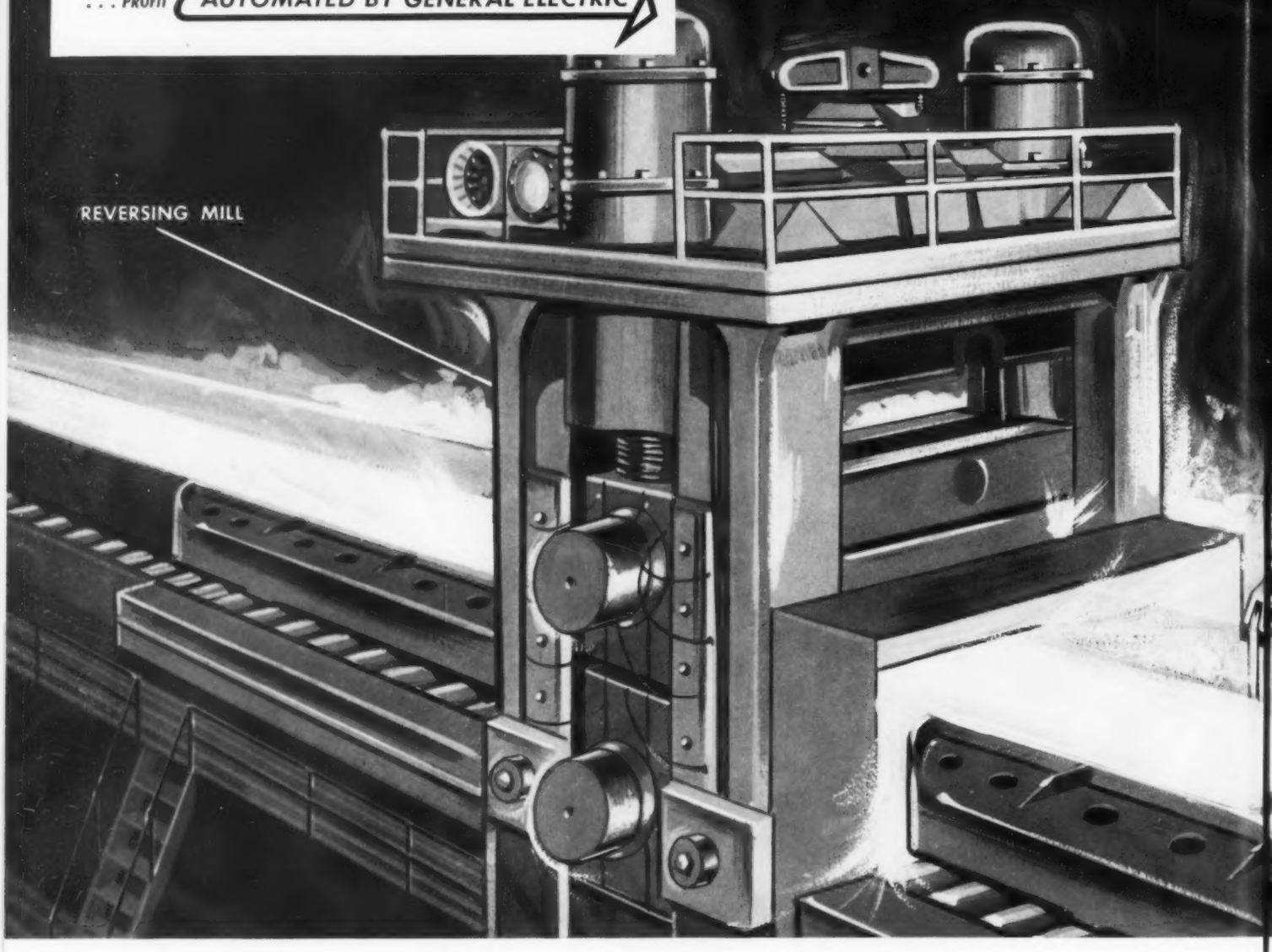

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G-E program-control system operates

General Electric's new program control for reversing hot mills performs an entire rolling cycle—automatically. Increased yield per ingot, substantially improved product quality and reduced unit cost are outstanding advantages of this new control system.

HOW G-E PROGRAM CONTROL OPERATES

The entire rolling operation, from ingot entry to finished slab, is controlled automatically. A punched card or other memory device is used for data storage and to control the entire operating sequence.

The cards are punched to perform mill functions previously determined to be the most efficient for the equipment involved and the product desired. This controlling element is read by an industrial card reader, which sends impulses to the control circuit and on to the screwdown motors, mill table drives, and manipulator drives. The operator, seated in the pulpit, inserts the card into the reader, depresses a pushbutton, and then the control directs the entire operating sequence. The speed of the mill table, position of the rolls, manipulation of the piece, and sequencing operations for all passes are controlled automatically by the program control system.

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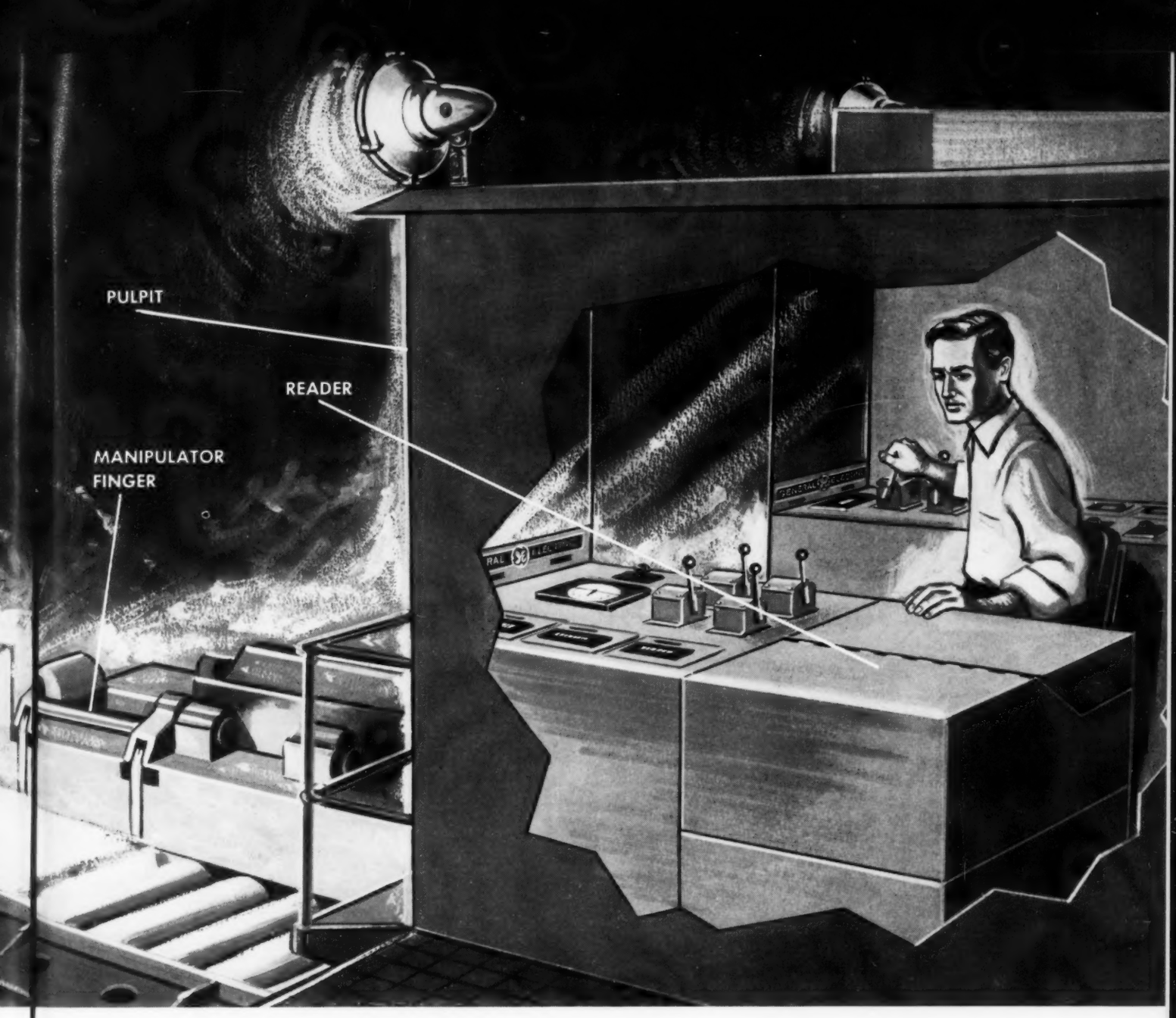

entire rolling cycle — automatically

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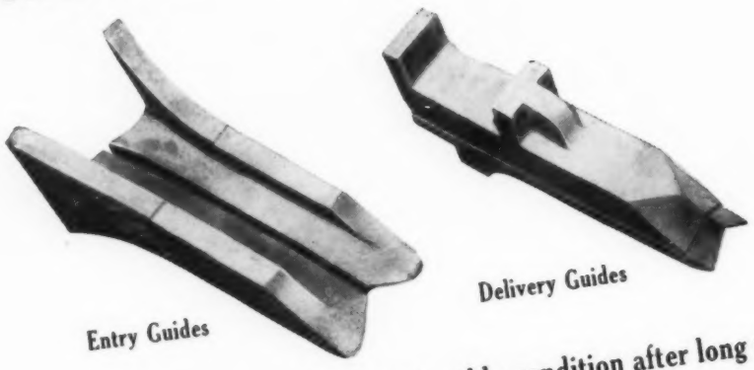
THE STEEL INDUSTRY

Steel Producers amazed at HIGH TONNAGE rolled with TRANTINYL GUIDES

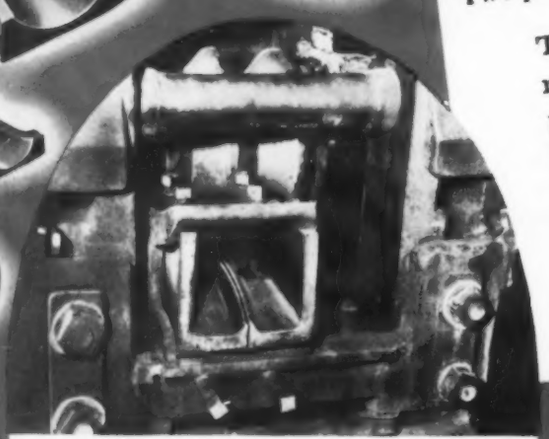


Entry Guides

Delivery Guides

Two pair of angle guides, still in serviceable condition after long usage

These entry and delivery guides on 12" mill were photographed in a midwest steel plant after rolling unusually high tonnage. Guides showed no noticeable signs of wear and proved again the outstanding durability of "TRANTINYL." If you have not yet tested "Trantinyl" guides to your own satisfaction, why not try them now.



12" Mill showing Entry Guides

"Trantinyl" Guides and Rollers hold exceptionally high tonnage performance records, in serving leading steel mills for a quarter-century. Rolling more than 100,000 tons over a single pair of guides has been recorded.

Guides for Rolling Mills • Tube Mills
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THE 100TH ANNIVERSARY OF THE OIL INDUSTRY

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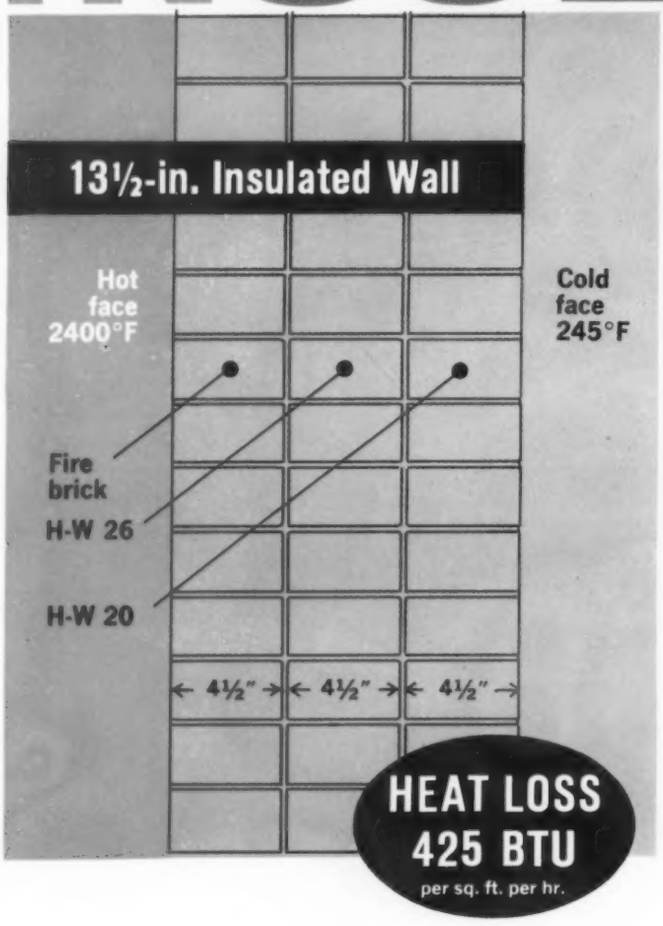
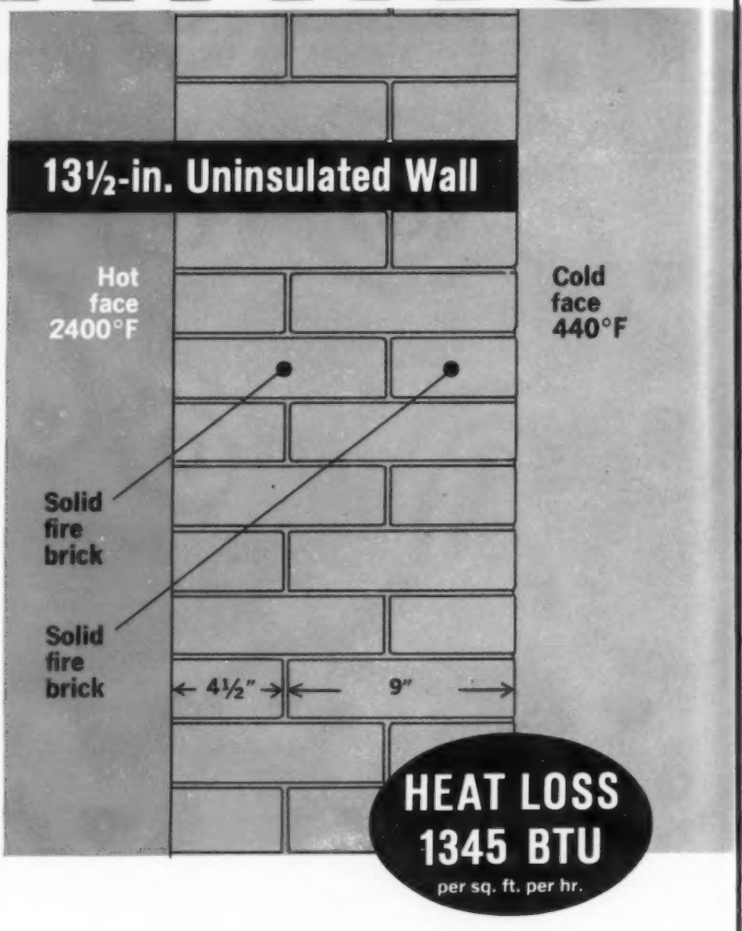
Stop heat losses with INSULATING





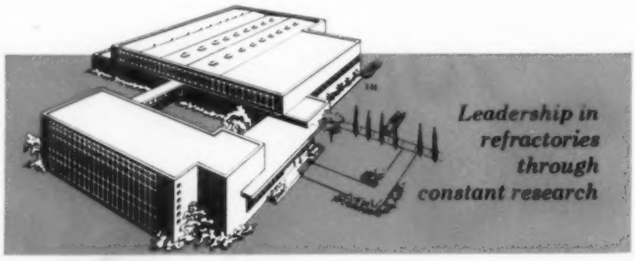
These furnace sections show how heat losses are reduced by using Harbison-Walker Insulating Brick for backing fire brick furnace walls. The heat loss is reduced 68.4%. These are typical of savings that are frequently experienced.

In addition to savings in fuel, floor space and weight, the use of insulating brick provides for faster heating and in some instances reduction of noise.

To assure best overall results, it is important that insulating refractories be carefully selected to secure the most advantageous combination of properties. Harbison-Walker having the full complement of both insulating and refractory brick, can furnish the correct combination for any requirement.

Harbison-Walker insulating brick have the balanced properties that mean dependable service. Light weight, essential to high insulating value and low heat-storage capacity, have been obtained to the greatest degree, consistent with the mechanical strength necessary for handling and for durability in service.

Technical service based on the most extensive experience and research is freely offered for assistance in determining the refractories best suited for each specific requirement.



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temperature 3000°F.

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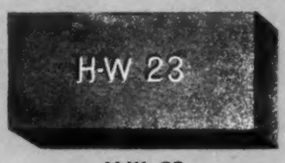
temperature 2800°F.

H-W 26
Maximum service
temperature 2600°F.



H-W 23
Maximum service
temperature 2300°F.

H-W 20
Maximum service
temperature 2000°F.

H-W 16
Maximum service
temperature 1600°F.

H-W insulating products include all the other types and classes which provide for every specific requirement.

1. **LOTHERM** having extra mechanical strength is particularly adapted for use in rotary kilns and for insulating glass tank flux blocks.

2. **H-W LIGHTWEIGHT CASTABLES** comprise five distinct kinds for the fulfillment of the diversified applications of monolithic constructions.

3. **H-W BLOCK INSULATION** and **H-W MINERAL FIBER COATING** are widely used with highly efficient added insulation for backing fire brick and monolithic structures.

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With Harbison-Walker insulation the time required to bring the furnace to operating temperature is materially reduced. This is a distinct advantage when furnaces are operated intermittently

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Insulated furnaces may be built closer to each other without affecting the comfort of the workmen. This not only permits more efficient handling but also reduces capital expenditures for floor space.

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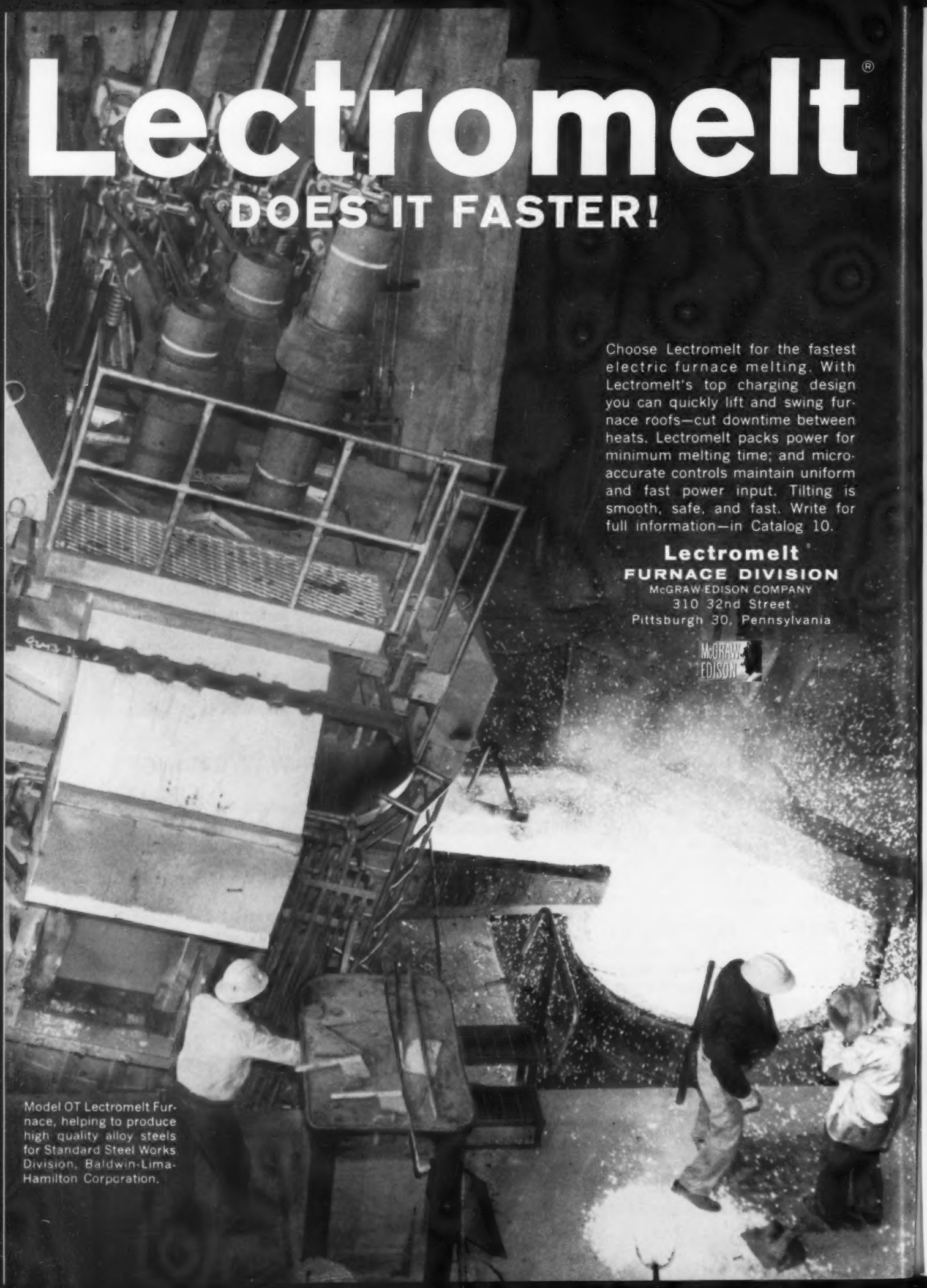

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The Role of the Industrial Engineer in the Steel Industry

by J. E. Angle,
Vice President,
Industrial Engineering,
United States Steel Corp.,
Pittsburgh, Pa.

For maximum benefit from an industrial engineering department, it should be given more responsibility in the area of cost control as related to usage of labor, equipment and materials; it should combine the traditional inductive analysis approach of breaking an operation down into its component parts with a deductive approach; and its personnel should be included in problems involving operation, equipment, quality control, scheduling and maintenance, and not confined to time study.

THIS paper will discuss how industrial engineering started, where it fits into the organization, what it does, and more importantly, what it should be doing.

It may be useful to go back in time and look at the origins of industrial engineering and "scientific" management. Some of the original concepts appeared in England early in the Industrial Revolution, but probably because of the secretive attitude of the managements of the period, no publicity was given them, and there is not much evidence that they were generally used. In the United States, the period from about 1880 to 1910 saw much activity in the field of scientific management. Many individuals, among them H. L. Gantt and Fred and Lillian Gilbreth, made lasting contributions to the development, but the one who is considered the father of "scientific" management was Frederick W. Taylor.

Taylor was an engineer employed initially by the old Midvale Steel Co., where he was first employed as a common laborer and subsequently worked himself up through the machine shop to be chief engineer of the company. He later worked for Bethlehem Steel Co. and subsequently did consulting work in the line of putting his ideas into practice. He had early deplored the rule-of-thumb methods employed in machine shop work and the fact that the worker himself was largely on his own in determining how the job should be done. He concluded that there should be one best way to do a job and that there should be one best machine or tool to use for the purpose. His experiments, based on this conclusion, were carried out at Midvale and formed the basis for a paper titled "Shop Management," which he presented to the American Society of Mechanical Engineers. Following this work he expanded his research into other types of operations, both at Midvale and Bethlehem. In 1903, he published another paper called "Scientific Management," in which he extends his earlier conclusions to a comprehensive application to any manufacturing process.

Shortly after, there arose a growing reaction on the part of organized labor to the newly announced concept of scientific management to the effect that it would be a means of throwing men out of work. When the U. S.

Government tried to apply Taylor's principles of management to the Watertown Arsenal, much adverse publicity resulted. Shortly after, Louis Brandeis, applying the term "scientific management" to the Taylor system, successfully undermined an appeal of the eastern railroads for a rate increase on the basis that their use of these principles had reduced their costs to the point that an adjustment was unnecessary.

The controversy over Taylor's system culminated in a Congressional investigation in 1912. The details are unimportant, but the results were. Scientific techniques were prohibited in government installations for a long time; and "scientific management" received a black eye and a serious setback, some of which still hangs like a cloud over *industrial engineering*, because the latter term was adopted as an euphemism, if you please, for "scieatific management."

To complete the background, a brief look at what Taylor advocated should be taken. The first principle was to develop the task in a scientific manner by analyzing the methods and the equipment, and selecting the best of each; second, to select the best fitted workmen for each job; third, to educate and train the worker in the best method; and fourth, to establish a co-operative effort between management and the worker, which would involve on the part of management proper planning and smoothing the way so as to make it possible for the worker to produce most effectively. Taylor said that his plan was characterized by science instead of rule of thumb; harmony, not discord; cooperation, not individualism; maximum output, not restricted output; and the development of each man to his greatest efficiency and prosperity. The net result, he claimed, would be a greater return to the worker because he would be paid on an incentive basis, a greater gain to the company and to the public because there would be more to share. These principles are still sound, but unfortunately, just as in Taylor's day, they cannot be completely put into effect.

This explains, at least in part, why industrial engineers are still the "problem children" of industry. The field of industrial engineering has not been precisely defined, and the uses to which industrial engineers are put vary widely from one company to another. There are situations where management has only the vaguest idea of what industrial engineers should be doing. Furthermore, where industrial engineers have been involved in methods and incentive work, there has often been labor unrest as a result. Of course, it can be said that, properly handled, such trouble could have been avoided, but the point is it has not been, and the industrial engineer is inevitably associated with trouble. It is a very human tendency to push trouble under the rug when possible, and in all too many instances that is exactly where the industrial engineer has landed.

Industrial engineering has too much to offer to relegate it to a routine or inferior position in the management organization, and we would like to suggest ways in which we can realize the benefits that are possible through the use of their techniques.

An industrial engineer, if properly trained should have certain attributes that are not precisely duplicated in any other branch of engineering. His scientific training is sufficiently general that he is not an expert in any one field and yet he should be able to understand most scientific problems. In addition, he should have more than a speaking acquaintance with modern cost accounting principles, sound organizational concepts, and even an understanding of psychology and labor relations. Most importantly, he should be trained to be objective in his thinking because it is this quality which will ultimately determine his value to management. His position in the organization should be *advisory* to the operating function. Otherwise the desired objectivity would be lost. He should be available to all levels of management from the front-line foreman to the president.

Industrial engineers are not properly used in many instances. There are two reasons for this, the first being that line management does not know how to use industrial engineers, and the second that the engineers themselves are partially at fault. In most organizations, management assigns certain definite responsibilities to the Industrial Engineering Department. These commonly involve job evaluation, time study, methods, budgetary control, and in some cases plant layout and product design and perhaps process control. Since it is nice to have things properly defined and neatly fitted into compartments, it often follows that the Industrial Engineering Department slips into the routine performance of its assigned duties, and both management and industrial engineers are quite satisfied to let it stay there. This, I think, is where one of the big mistakes is made. Men will grow only if they are required to do more difficult things, and unless management intentionally throws new jobs and new tasks to its industrial engineers, they will never develop beyond their established boundaries. Soon we begin to conceive of the Industrial Engineering Department as a fixed number of people, and as the available personnel are loaded up with routine work, it becomes difficult, if not impossible, for them to handle anything else. When an entirely new development comes along, such as "operations research" as it is called, the industrial engineers are overlooked and possibly a completely new function is established to handle the new technique. Yet inherently many of these new ideas are merely an extension of what might well be considered the industrial engineering field. In our opinion, it is probably easier for a competent industrial engineer to learn the new development and apply it properly to the company's particular problems than it is to employ an expert and acquaint him with the internal situation. We would recommend that in the management of the industrial engineering function it be regarded as a flexible organization which, though assigned certain repetitive and routine duties, is still staffed adequately to handle new and different assignments.

By so doing, we can avoid adding another staff department to the organization. Not only are a simpler structure and clear lines of responsibility maintained, but the trend toward heavier overhead is resisted. The more individual staff entities, the more clerks, secretaries and other office personnel must be added to the pay roll simply because it is difficult to pool such service for several departments to use. Management must consciously create the proper environment for the most effective use of any staff service, but this is especially so in the case of industrial engineering. There must be a clear understanding on the part of operating

supervison and other staff departments as to who is responsible for what. As a rule, when industrial engineering is working on a project that involves operations, the engineer should be responsible for the soundness of the results, but line supervision will put the project into effect and, consequently, should have a voice in the development. Other staff departments often fail to make use of industrial engineering service, so it is top management's job to bring them in. In making assignments, general superintendents and others often fail to bring together all parties that are involved, and in far too many instances industrial engineering is either left holding the bag or the job drags out until finally all the necessary people get into the act. In a recent article on concentration, it was pointed out that if we would only concentrate properly on one thing at a time, we would get far more done and at a considerable saving in time. A lot of effort is wasted because first, not enough time is spent defining a problem, and second, it is not assigned to all of the right people, i.e., certain individuals or functions who could be of help are left out. Both of these faults reflect a lack of concentration.

What is needed, perhaps, is a short paper for general superintendents on how to use industrial engineers profitably. I would operate differently now. No longer would I load the industrial engineers with clerical routine or permit them to get into a rut and stay there. I will elaborate as to what I *would* do.

Before that, perhaps we should describe where we think industrial engineers dig their own graves. For one thing, they take too long to get a job done, and in most cases unnecessarily so. No doubt this is a result of a desire for accuracy, but accuracy is a relative thing and should be no more precise than is required. During the war, we listened to the manager of a local plant tell of the troubles he was having in making trench mortars. The inspectors were insisting on a tolerance of something like 0.0002 in. on the diameter of the firing pins. What bothered him though was the fact that in service, when the firing pin was lost or damaged, the troops would replace it with a spike and keep right on firing. There is no use in taking a month's time study on a crew, for example, if you are going to let the foreman guess what the operating speed of the facility is going to be. As a matter of fact, in developing work loads for large groups such as maintenance crews, it is quite practical to use work sampling and forego time study altogether. It is quite possible that as our equipment becomes increasingly automatic, time study may be replaced completely—at least industrial engineers ought to be giving the matter serious thought. Certainly if we practice what we preach, we should be constantly seeking ways to improve the way we do our business. Specifically, it is always healthy to make a periodic work sampling in any service department, not only to find out how much of the time people are working, but also whether their skills are being used properly. This should apply especially to the Industrial Engineering Department.

Another characteristic frequently found in industrial engineers is a tendency to fall back on the written procedure to support their position, rather than to argue from logic and experience. There is a marked distinction between policy and procedure. Policy is a company's code of ethics; procedures are time savers to assist in policy administration. To quote procedure as law implies that there is no other sound reasoning behind the engineer's argument. We have even heard one vigorously defend his position on the basis that the procedure backed him up, and when asked who wrote it, he had to admit that he did. What is done should be based on good judgment and common sense; the time will never come when problems can be solved simply by reading out of a book or pushing a button.

Industrial engineering work, when it reaches the stage of installation, must be practical, realistic and understandable, regardless of how theoretical the development may have been. To accomplish this, the engineer must maintain the closest possible contact with the operating organization so that he is constantly attuned to its problems and to any new plans or programs that are being initiated. When staff men feel that they are being left out of things or do not know what is going on, it is usually because they do not take the trouble to find out for themselves.

The rather critical description given of both management and engineers with reference to the industrial engineering function is enough to provide a background for the principal point we would like to make. In other words, I do not think we manage our plants as well as we could. We hope to be able to indicate where improvement can be made.

The usual organization structure in a steel plant consists of line management, which operates and maintains the facilities, and various staff groups, which provide technical service and advice and counsel to the line. Broadly speaking, these staff groups consist of industrial relations, facility engineering, production planning, metallurgy and inspection, and industrial engineering. Accounting has been excluded since it usually does not report to the plant operating executive and is not staff in the normal sense of the term. Of the staff functions mentioned, each has fairly well defined responsibilities by the nature of the work, with the possible exception of industrial engineering. In other words, production planning is concerned with the acceptance, scheduling and delivery of customers' orders; the metallurgical department is responsible for the technical aspects of the steelmaking process itself; industrial relations is concerned with employment, training, safety and labor relations; and engineering is concerned with the physical equipment of the plant. Industrial engineering is the only staff service that is concerned with the broad question of *how* we manage. At least it *should* be involved in such matters to the point where it is the right hand of management, the guide to the most effective use of all resources and consequently the best profit performance—which is the primary objective of management.

If I were a general superintendent again, these are some of the things I would do:

First, I would give the industrial engineers much more responsibility in the area of costs in the sense of the physical quantities that are represented by costs. After all, dollars are just a convenient device to enable the conversion of many different things into a common denominator. What really counts is the usage of labor, equipment and materials that the costs reflect. The financial requirements of the cost system are a matter that the operator is seldom qualified to judge, but the controls that the operator needs from the cost system

are a matter in which he should have a voice, and here the industrial engineer should be his advocate and counsellor. It should be his obligation to provide line management with the tools which, properly used, will result in good cost control. The operator should know in advance how many hours of direct labor he can schedule for next week's forecasted production. He should know how many hours of maintenance he can afford to spend. He should know for each product what his production rate should be. He should know how much he can afford to spend on repair materials and tools and supplies, both monthly and weekly, based on anticipated operations. As against these standards, he should receive current reports to tell him how he is actually performing, and these should be of such frequency that he can take corrective action before it is too late. If he has problems of performance, the industrial engineer should be able to identify the causes and advise him as to corrective action. I would also expect the industrial engineer to be the instrument through which standards were maintained, in co-operation with the operator, and I would further expect that in all of the above forecasting and reporting he would make use of the most modern and economical office techniques. Furthermore, I would expect him to be a sort of "personal gadfly" to each superintendent, showing him where improvement can be made and then helping him to make it. I am convinced that American industry in general does not know enough about costs and, as a corollary, does not have adequate information to improve them. I would use the industrial engineer to his full capacity in correcting this deficiency.

The second thing I would do is to set apart a definite percentage of industrial engineering time to be spent on what is now becoming known as systems research. This is methods work, but with a difference. The usual concept of methods study consists of selecting an operation, breaking it down into its individual components, analyzing these for elimination or improvement, reconstructing the better method and putting it into effect. This is otherwise known as the scientific method of problem solving or, in logic, inductive reasoning. It has served us well, but there is a growing awareness that this approach tends to overlook large potential by concentrating on the bits and pieces. In logic, the reverse of inductive reasoning is called the deductive method, by which general principles are first stated, and from these, certain conclusions are drawn and then confirmed. Some of our greatest scientific advances were the result of deductive reasoning. Translating this principle into our own field, we are finding that if we observe an operation in its entirety, as a complete system, it is possible to discern major faults or inconsistencies that, if solved, could lead to substantial gains. New tools and techniques have served to give impetus to the practical application of this principle. Electronic computers have made possible the simulation of a complete operation in mathematical terms, and because of their rapidity, a synthetic operation can be run through a sequence of cycles under variable conditions in a very short period. New methods of scheduling, manning and transporting can be tried out on a theoretical test run without ever involving the operation itself. Other techniques involve such mathematical applications as the theory of games, probability and linear programming. Other approaches are simply a revival of the practice of setting up a complete but concise process flow chart which can be studied by operators industrial engineers or other staff and accounting services. The technology employed can be as sophisticated as you want to make it; the important consideration is to look at the whole problem, not just the parts. This is not to say that the traditional methods approach is wrong, because it has worked. If I were running a plant, I would have my industrial engineers doing both.

I would also use the team approach on more problems. Rather than assigning industrial engineers exclusively to a study, I would use them as part of a small group, with qualified people from the several functions that were involved. Whether the industrial engineer would be chairman or not would depend on the nature of the project, but I would see to it that his participation was assured. Projects involving operations, facilities, quality, scheduling, maintenance or clerical work should all present opportunities to a competent industrial engineer, and I would expect him to make a contribution or find some one who would.

Take automation as an example. We are all installing more automatic control devices, especially on new equipment. This kind of instrumentation costs money, which can be returned only through higher production, quality or lower man-hours. How will you determine whether you have established the right jobs and the proper number of people to operate and maintain the new equipment? Will you leave that entirely up to the operator or will you make sure that he avails himself of the best talent possible to guide his thinking? If you conclude that the industrial engineer should be a part of the study of how to man the equipment, does it not make sense that he be brought in early enough that he is not dealing with an accomplished fact? In short, I would have industrial engineers participating in facility projects from their inception—not in a position of primary responsibility, but as active members of the team. They would be expected to help in matters of layout, product flow, manning and design of jobs and forecast of benefits. Experience has proved the value of this approach.

Other functions which are traditionally assigned to industrial engineering, such as work measurement and incentives, cost reduction and basic standards or budgetary control, can all be done more effectively if the engineering effort is properly integrated into the whole management effort. Problems of communications and responsibility tend to disappear under such an arrangement, and the recommendations for action are not only understood by all concerned, but are usually accepted when presented. Management must see that the proper environment and organization relationships are provided if we are to capitalize on the abilities of our industrial engineers.

It is never too late to change. The new developments and technologies that are now available to management can bring about amazing benefits if properly used in conjunction with existing knowledge and experience. We may, in fact, be on the verge of a major advance in our economic progress. Industrial engineering can be an important factor in bringing this to pass if we will do the things necessary to make their full participation possible. ▲

The use of blast furnace and coke-oven gases as boiler and coke-oven fuels, of coke-oven gas as an open hearth fuel, and the potential use of blast furnace gas as fuel in gas turbines for blast furnace blowers driving will help conserve dwindling coal supplies and reduce steelmaking costs.

Utilization Of By-Product Fuels

by R. W. Worley,
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THE term "by-product fuel" may well be applied to the familiar tar, coke breeze, coke-oven gas and blast furnace gas which are found in important quantities in any completely integrated steel mill. These materials have often been referred to as "waste gases" or "waste fuels"; however, their increasingly profitable use makes the term "by-product fuel" much more appropriate.

The source of these by-product fuels is, of course, coal. Our country is fortunate in having an abundant supply of this prime resource. Numerous surveys and forecasts have been made concerning the extent of the national coal pile. These have ranged from the qualified optimism of a 2000-year supply to gloomy predictions that the next century will see the practical end of the coal. The diversity of these estimates arises partly from differences of opinion as to the rate at which use of fuel will increase, and partly from the uncertainty of the extent to which the known reserves can be recovered and used. The steel industry, which is now using more than 100,000,000 tons annually, has a vital interest in conserving the supply.

There are two principal avenues of approach to conservation of fuel, and it is gratifying to observe that the industry is making substantial progress in both. The first possibility lies in decreasing the amount of fuel used in blast furnaces. This requirement varies with the quality of the ore, the nature of the gangue and the furnace practice, and may range from over 2000 lb to as little as 1400 lb of coke per ton of iron produced. Ore beneficiation, increased use of sinter, judicious blending of the burden and general advances in operating practice have all contributed to a steady decline in the coke rate which now approximates 1700 lb per ton of iron as a national average. It has been predicted that this figure will shrink another 100 to 150 lb as high top pressure, oxygen enrichment and controlled humidity of the blast become better understood and more widely practiced.

The second opportunity to conserve coal lies in full utilization of the by-product fuels. Generally speaking, the energy requirements of steel mills are increasing, and any waste of by-product fuels must be made up by purchase of steaming coal, fuel oil, natural gas or electricity. These are the irreplaceable fossil fuels or the product thereof. Each of us concerned directly or indirectly with use of energy in the steel industry has a moral obligation as well as an economic incentive to make the best and fullest use of the by-products.

The purpose of this paper is to review the by-product fuels with respect to production, characteristics and uses. The material presented here is not new, but the subject is so important that a restatement of basic principles is in order. It should be emphasized that the figures presented in the following discussion are, for the most part, averages and so may not agree exactly with figures obtained in actual practice at any given plant. Small losses incidental to the several processes have been ignored.

Let us consider what happens to a ton of coal proc-

essed at the coke plant of an integrated mill. This may be a single grade of coal or it may be a blend of several grades carefully selected to create desired properties in the product. This is charged into an oven and heated for 15 to 20 hours, during which time almost all volatile matter is driven off. As shown in Figure 1, the coal is converted to about 580 lb of gaseous products and 1420 lb of solid products.

The raw coke-oven gas, heavily loaded with tar, water and light oil vapors passes through an extensive cleaning system in the modern by-product recovery installation. Tar vapors are removed by cooling the gas in direct contact with water in the flushing mains and later in large packed towers supplied with cooled water. Remaining traces of tar are eliminated by electrostatic precipitation or high velocity oil scrubbing. The gas is then compressed and further washed with oil to remove benzene and other light oils. Prior to benzol recovery the gas is washed with sulphuric acid solution to remove ammonia and form ammonium sulphate, an important ingredient in fertilizer. The treatment of the gaseous products yields about 315 lb of coke-oven gas, 125 lb of tar, and 140 lb of chemicals and waste liquors.

Figure 1 shows about 40 per cent of the gas used for heating the ovens. After this requirement has been satisfied, there remains a surplus of 190 lb of gas with a heat content of approximately 3,700,000 Btu.

The crude tar is sometimes used as fuel or is sold. The modern practice is to provide distillation facilities for separation of the pitch from the lighter fractions. The pitch may be sold or used as fuel, generally after being cut back with light oil for easier handling. In Figure 1 the pitch is assumed to be surplus with a heating value of 1,400,000 Btu.

Crushing and screening the solid product yields approximately 1280 lb of metallurgical coke and 140 lb of coke breeze. The coke, when charged into a blast furnace, will produce about 6760 lb of blast furnace gas. Some 25 to 30 per cent of this is used for stove heating, the exact amount depending upon the heating value of the gas and the hot blast temperature required for the particular furnace practice. An average value has been used here, and Figure 1 shows 4870 lb of excess gas with a heating value of approximately 5,700,000 Btu. The coke breeze is not required for any fundamental purpose and so is assumed to be entirely surplus. The heat content of the breeze is 1,400,000 Btu.

There are then remaining from the original ton of coal 12,200,000 Btu of available energy in the forms of gas, pitch and breeze. This is a convenient point to change the terms of reference from ton of coal to ton of iron. If the 1700-lb coke rate is assumed, the surplus energy figure becomes 16,200,000 Btu per ton of iron. Most plants today have need for all this energy. If by-product fuels are not used, they must be replaced with purchased fuels. The 16,200,000 Btu are equivalent to 1250 lb of steaming coal, 110 gal of Bunker "C" fuel oil or 15,400 cu ft of natural gas.

Consider now the characteristics of the by-product fuels and the uses to which they may be put.

Coke breeze is usually defined as that portion of the coke which will pass through a $\frac{5}{8}$-in. screen. A typical size analysis shows seven per cent larger than $\frac{1}{2}$ in., 31 per cent larger than $\frac{1}{4}$ in., 27 per cent larger than $\frac{1}{8}$ in., and the balance of 35 per cent in fines. The heating value ranges from 10,000 to 11,000 Btu per lb due principally to the rather wide variation in moisture. As might be expected with such fine material, the moisture content is greatly affected by standing time in cars, exposure to the weather and conditions of storage.

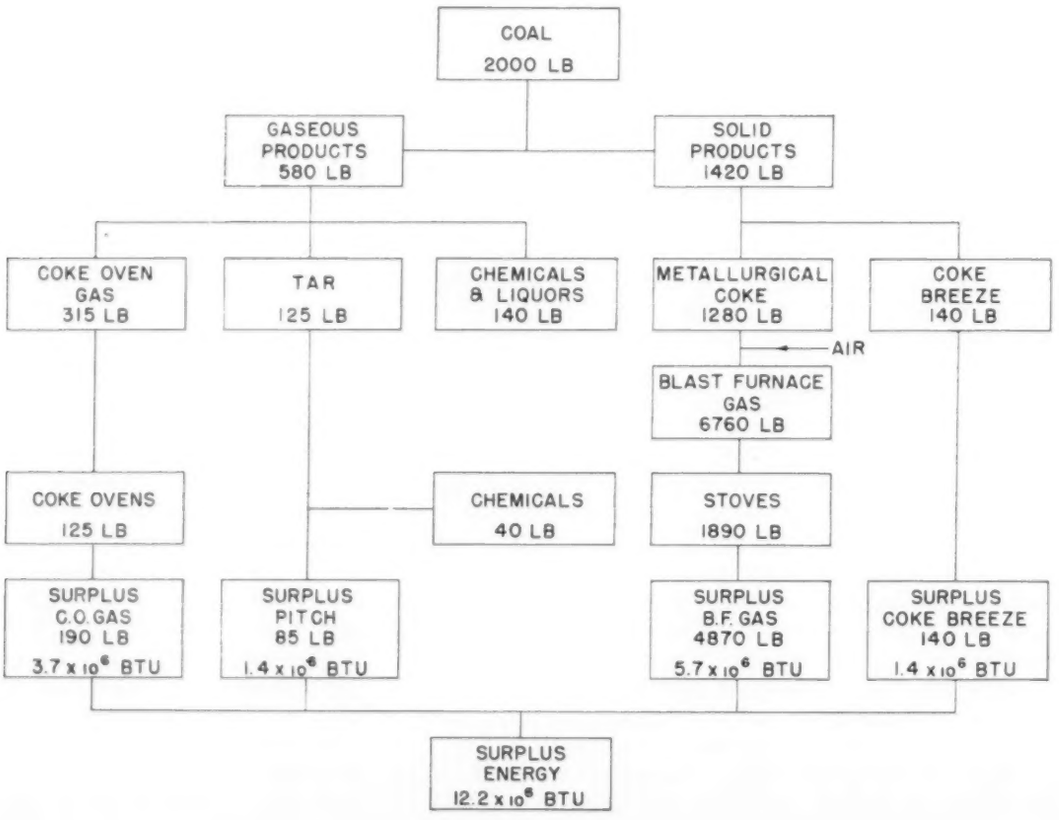

Figure 1 — By-product fuels from one ton of coal.

Despite the small particle size, breeze is satisfactory as a boiler fuel when burned in properly designed equipment, and boiler efficiencies approaching 85 per cent can be realized. Breeze commonly is fired on a traveling grate stoker. This imposes a limitation on forced draft temperature and suggests a modest air heater plus an economizer for good heat recovery.

Appreciable carry-over of unburned carbon is inherent in breeze firing. This is caught in the hoppers under the economizer and last boiler pass and should be returned to the furnace. If the equipment is properly operated, there is so little combustible in the fly ash that reinjection to the furnace from a dust collector cannot be justified.

In the past, breeze has been used principally as boiler fuel with small amounts being used for sintering of flue dust and sale to outside consumers. The supply generally exceeded the demand and mountainous piles of breeze were commonplace in many plants. Recently the sintering of ore has become more prevalent, and the trend is expected to continue. An indication of this can be found in the AISE Yearly Proceedings, 1957 which lists announced plans for installation of new sintering lines with a capacity in excess of 50,000 tons per day. The stockpiles of coke breeze either have or are about to disappear, and with them, in some cases, use of breeze as a boiler fuel. In one plant over 500,000 lb per hr of steam generating capacity have been converted from breeze to coal firing.

It is unwise to generalize concerning the utilization of tar. The situation varies from plant to plant, depending on recovery equipment available, the need for fuel and the market for tar derivatives. Pitch has a heating value of about 17,000 Btu per lb, and when cut back with tar or some other diluent is widely used as an open hearth fuel. It is also fired to some extent in boilers.

Coke-oven gas is the most versatile of the by-product fuels. It is rich, generally clean and convenient to distribute and use. The heating value, which ranges from 500 to 600 Btu per cu ft, is derived principally from methane, hydrogen, ethylene and carbon monoxide, in that order. The percentages of these constituents vary considerably with the coal used and details of the coking process. The gas can be burned satisfactorily with about 15 per cent excess air and produces a short, hot flame. It is an excellent boiler fuel and frequently is fired in conjunction with coke breeze to provide the response to rapid load change not obtainable with breeze alone.

Coke-oven gas can be used for almost any heating requirement in the mill. About the only limitation on its usefulness arises from its sulphur content. If the gas was made from a high sulphur coal, the amount of hydrogen sulphide present may preclude using it for open hearth or other direct contact metallurgical purposes.

Excess coke-oven gas has traditionally been sold to gas utilities for distribution. With the arrival of natural gas in most of the coke-oven served areas, this market has become less attractive to the steel companies. Considerable attention has been given to use of this valuable gas for chemical purposes. The gas is rich in hydrogen, one of the basic ingredients in the manufacture of synthetic ammonia. There are two plants in the United States now making use of the hydrogen to produce additional revenue. In 1956, a chemical processing plant was built to produce 45,000 tons per year of ammonia. In 1957, a large steel corporation started production in a 200-ton per day anhydrous ammonia plant. This latter plant also makes ammonium nitrate and nitric acid. The nitrogen is supplied by an air separation plant with the by-product oxygen going to the steelmaking processes.

It is too early to predict the extent to which steel companies may invade the chemical field. So far, they have not tried to create chemical markets, but have been guided by existing demand. It is fairly accurate to say that most plants have barely scratched the surface in recovery or production of chemicals. Table I shows the quantities of substances per ton of coal which could be recovered in a by-product operation.

The last by-product fuel to be considered is blast furnace gas. It is produced in such prodigious quantities that it cannot be ignored and should not be wasted. A 1000-ton per day blast furnace, for example, will produce 80,000 to 85,000 cu ft per min of gas when on blast.

The gas issues from the furnace top and is led through the downcomers to the dust catcher and washers. The gas leaving the washers is termed "primary clean" and contains 0.15 to 0.20 grain of flue dust per cu ft. At this point, the gas can be used as fuel, but only at the expense of considerable maintenance for cleaning pipes, burners and flues. Early installations of washers or similar equipment provided cleaner gas for internal combustion engines driving blowing engines or electric generators. Often the gas used as boiler fuel was only primary clean.

It is now common practice to provide second stage cleaning for all gas. This usually is done with electrostatic precipitators located near the furnaces which reduces the dust content to 0.015 grain per cu ft. This greatly improves operation of the stoves, boilers, etc., and increases the periods between cleanings. There is an increasing use of blast furnace gas for underfiring coke oven batteries, thus releasing coke-oven gas for other purposes. The gas used at the ovens may be subjected to a third stage of cleaning, leaving it with a dust content of only 0.0015 grain per cu ft. For underfiring, the blast furnace gas may be burned alone or it may be enriched with coke-oven gas.

Blast furnace gas is a lean fuel with a heat content of 80 to 100 Btu per cu ft. This heat value is derived chiefly from carbon monoxide which constitutes 20 to 23 per cent of the total. Needless to say, the gas is extremely poisonous and precautions must be observed to handle it safely.

So far as the authors are aware, there is no chemical or process use for blast furnace gas, either now or in immediate prospect. It appears it will continue to be used only as fuel.

The gas has been used rather efficiently in internal combustion engines. However, these engines require high operating and maintenance labor and considerable physical space for a given output. A number of the old engines are still operating, but undoubtedly will never be replaced in kind.

Boilers for firing blast furnace gas require special

design considerations. As the gas is so lean, ignition is a problem and continuous pilot burners are required. Flame temperature is low, and large heat absorbing surface and furnace volume are needed. The physical size of a gas-fired boiler of 500,000 lb per hr steam generation will approximate that of a 1,000,000-lb per hr boiler burning oil or pulverized coal. In mills where utilization of blast furnace gas is high, the boiler plant is likely to have lowest priority on use of gas. It is necessary to provide a supplementary fuel to be fired automatically when the gas supply diminishes, as during furnace checks.

An interesting new development in the use of blast furnace gas is the gas turbine as a driver for blast furnace blowers. These machines offer the advantage of direct conversion of gas to cold blast found in the old gas engines. They also provide the flexibility and space saving features of the steam turbine without requiring the capital cost of a boiler installation. United States Steel Corp. is pioneering a gas turbine-driven blast furnace blower installation at U. S. Steel Corp.'s South Works. Also the development and details of this project have been ably presented in papers read before the AISE. It is sufficient to say that the project is being followed with great interest by power engineers who are hopeful of an early report on actual operating experience.

Discussion

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George H. Krapf: We have found ways and means of making a profit from by-product fuels, which has been touched upon in the paper. I would like to mention, however, that we have found coke-oven gas to be a very good metallurgical fuel for use in our open hearths, soaking pits, reheating furnaces, etc. Where sulphur has been a problem, desulphurization equipment has been used in many instances.

At one time, blast furnace gas was considered to be something for use only in boilers. However, we have learned to utilize it very efficiently in our soaking pits. We have succeeded in designing soaking pits that burn a 100 per cent blast furnace gas year-in and year-out, and it does a fast and metallurgically good heating job. As far as I am personally concerned, it is probably the No. 1 fuel for firing a soaking pit.

The utilization of blast furnace gas in our reciprocating engines is an excellent example of its value. They are a monument to the genius of the engineers who designed them; and although they are now costly to maintain, blast furnace gas is converted in them to mechanical energy at an efficiency that is difficult to surpass.

All of us, of course, stand on the shoulders of the people preceding us, and we should be more proficient engineers just for that reason. The latest development for the utilization of blast furnace gas is the gas turbine, which was briefly noted in this paper, and we consider it to be of great economic potential within our corporation.

As I said earlier, the urge to realize financial benefits will lead us along the lines that were outlined in this paper to the end that the maximum conservation, and use of this vital resource will result.

John J. Alexander: I cannot find any valid objection to the author's theoretical utilization of by-product fuels. I certainly agree that we have a "moral" obligation as well as an economic incentive to make the most complete use of by-product fuel. We cannot ignore the fact that continued use of obsolete, inefficient power generating equipment results in waste of by-product fuels as surely as the practices of bleeding gases.

I do not agree with several statements of the practicable distribution of fuel. Blast furnace gas used for stove heat with good stove operation and efficient gas distribution should be 20 to 24 per cent of total gas produced rather than 25 to 30 per cent as suggested.

The paper suggests boiler efficiency approaching 85 per cent with coke breeze fired on a traveling grate stoker and boiler equipped with economizer. While this is possible, I suggest that longer outage periods for maintenance of stoker and economizer will result in less efficient average use of by-product fuels.

I certainly agree with the necessity for continuous burning pilot burners for boilers firing blast furnace gas. Burners and boilers designed for 90-Btu gas, with recent changes in blast furnace burden practice, must utilize gas at 76 Btu per cu ft with 1350-lb per ton coke rate. If design of boiler fans is adequate and auxiliary fuel arrangement is flexible, blast furnace gas at 73 Btu per cu ft can be utilized efficiently without interruption to steam and electric power production. It is essential that pilot burners be adequate and frequent checks be made to avoid plugging of tips due to improper performance of coke gas cleaning equipment.

I suggest that all equipment designed for use of blast furnace gas should be arranged for use of supplementary fuel or gas distribution system arranged for enrichment, since the trend to even lower coke rate of the blast furnace will probably produce gas with heat content less than 75 Btu per cu ft.

Efficient use of this very lean by-product fuel will be essential and is a "moral" obligation as suggested by the authors. It will probably require more skill than has been demonstrated to use it efficiently and economically as boiler or gas turbine fuel.

R. W. Worley: In the paper there are some figures that are very significant. One of them is the improvement in coke rate for the blast furnace.

According to the Bureau of Mines paper, Report 2780, July, 1958, the coke rate was 1703 lb of coke per ton of iron. It is significant that this was 15½ lb less than the 1956 average coke rate and 234 lb less than the coke rate in 1948.

Regardless of the incentive, the steel industry is doing an excellent job in making use of everything that is around and saving money, as well as our basic resources.

TABLE I
Possible By-Product Derivatives of Coal
(lb per ton of coke)

Coal gas		Coal tar and light oil	
Carbon monoxide	43.2	Benzene	11.80
Hydrogen	30.4	Toluene	2.72
Methane	132.0	Xylene	1.33
Hydrogen sulphide	6.7	Naphthalene	6.48
Hydrogen cyanide	1.7	Phenanthrene	2.26
Ethylene	19.6	Anthracene	0.64
Propylene	3.4	Pyridine	0.16
Ammonia sulphate	20.0	Quinoline	0.13
		Phenol	0.95

Table I outlines the various chemicals that are available. I would like to add some of the available uses of these chemicals:

Carbon monoxide can be used for the synthesis of higher alcohol, menthol, the formation of carbinols and for iron processes.

The hydrogen, of course, can be used for hydrogenation of heavy oils, ammonia and the upgrading of by-products.

Hydrogen sulphide can be used for the manufacture of sulphuric acids. Hydrogen cyanide, for fumigants and pesticides of all kinds.

Ethylene can be used for polyethylene plastics, even nylon, and ethylene glycol anti-freeze.

Propylene is also used for plastics and gasoline. Ammonia sulphate is used for fertilizer.

Benzene, toluene and xylene are used for plastics, paint solvents, explosives, lacquers and insecticides.

Naphthalene is used for moth balls. Phenanthrene is used for plasticizer in paints, anthracene for dye intermediates and drugs and pyridine for the same.

Quinoline is used for photographic supplies and drugs and phenols for plastics, insecticides and disinfectants.

For every one of those products that we mentioned, a dollar sign can be applied, and in this business, and these days of extreme competition, the dollar sign is quite important.

I know one operation right now that is burning toluene because they have no other way of getting rid of it, and they are very thankful that it can be burned in the boilers.

The use of blast furnace gas in soaking pits is one thing that was not mentioned in the paper but has become increasingly important and increasingly valuable. I think there is one thing we must remember, however, that the transportation of blast furnace gas from its source at the blast furnace to its point of usage in the soaking pits requires large sized iron pipe. This is not always simple. If we could locate the soaking pit right next to the blast furnace, we could save ourselves a lot of gas piping, but that might introduce even worse problems. But this is something to think about when we integrate a plant.

We were interested in Mr. Alexander's comments about improvement in blast furnace gas in burning the leaner gases in boilers. There is no question that it can be done without any difficulty if we approach it and accept it in making the design.

The paper stated that the present 500,000-lb boiler burning blast furnace gas around 90 to 100 Btu is equivalent to a 1,000,000 lb per hour boiler burning oil or pulverized coal. It is just a question of making it a little bit bigger and maybe it will be equivalent to a 1,500,000, but if it does the job of burning efficiently, there is no problem as we see it. The volume will just be larger.

We certainly agree with Mr. Alexander that, as the fuel gets thinner and leaner, we must have more reliable fuels as supplementary backup, but again this is no problem. ▲

Available Translations

As a service to readers of the Iron and Steel Engineer a list of translations from foreign articles is being printed intermittently. Articles selected for this listing will be those thought to be of primary interest to the American steel plant operator. The papers may be obtained from the Cooperative Translation Service, The Iron and Steel Institute, 4 Grosvenor Gardens, London, S. W. 1, England. All correspondence concerning price, ordering, and so forth should be directed to that address.

1193 Red'ko, A. N.: "Utilisation of Manganese in Ferro-manganese when operating the Blast Furnace on Oxygen-enriched Blast," *Metallurg*, 1958, Sept., pp. 7–10.

1201 Mut'ev, M. S.: "Definition of the Oval Pass Area," *Stal*, 1958, Sept., pp. 823–824.

1209–1211—"Plain Metal Bearings with Pure Hydrodynamic Lubrication for Roll Necks" *Stahl u. Eisen*, 1958, Dec. 25.

1209 Sprenger, B.: (A.) "Bearing Unit with Neck Bush and Tapered Roll-neck," pp. 1853–1861.

1210 Mullenbach, W.: (B.) "Roll-Neck Bearings with Running Surfaces on the Roll Neck for Large Oil Throughput," pp. 1861–1865.

1211 Frohling, J.: (C.) "Roll-Neck Bearings for Hydrodynamic Lubrication," pp. 1805–1867.

1217 Wubbenhorst, H.: "Comparative Data for the Operation of Open-Hearth Furnaces" *Radex Rundschau*, 1958, Nov. (7), pp. 348–353.

1246 Kazarnovskii, D. S.: "Ways of Solving the Rail Production Problem," *Stal*, 1958, Feb. pp. 138–144.

1170 Schutte, W., et al.: "Organization of Supplies and Production and Its Place in Planning and Management." I—Economy of Materials, Planning of Work, Recording and Signalling Systems. *Stahl u. Eisen*, 1958, Aug. 8, pp. 1045–1064. (Abstract J.I.S.I., 1958, Feb., p. 200: The authors describe in great detail the internal accounting and recording system, including supervision of smelting, melting and refining processes and the working at the various stages, as used by the August-Thyssen-Hutte Duisburg-Hamborn. From the metallurgist's point of view, the various card records are of value for statistics.) Part II of this article is B.I.S.I.T.S. No. 799.

by R. M. Sills and G. E. Terwilliger, Metal Rolling & Processing Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

Present Status and Trends In Data Processing and Programming

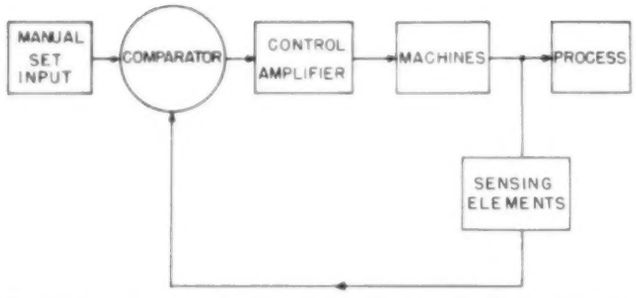


Figure 1 — In the ordinary regulator, a feedback control loop is the basic unit in most modern drive systems.

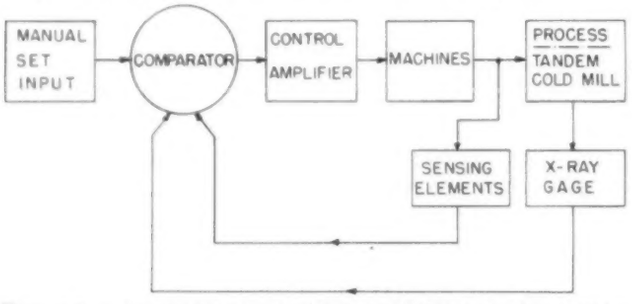
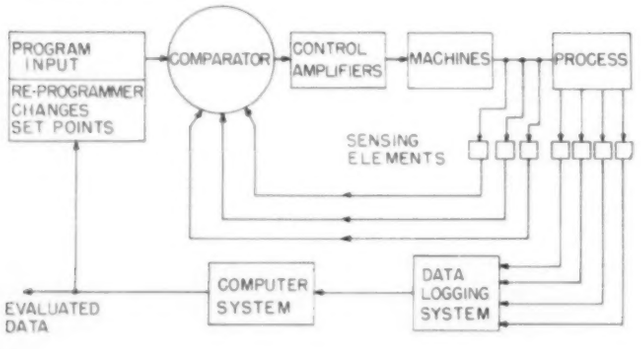


Figure 2 — In recent years a few regulators, such as automatic gage controls, have been built which directly control a product variable.

Figure 3 — This proposed regulator has an additional data logging and computing loop for reprogramming the "set point" or input.



WHAT do we mean by "data processing and programming?" Both of these terms have multiple definitions, but here we are talking about some rather explicit meanings. We should make clear at the outset that we are speaking of "mill" data processing, as opposed to "business" data processing. The former deals directly with physical measurements whereas the latter is largely concerned with dollars or statistics.

Since definitions are not worth much unless they are given in meaningful terms some illustrations will be used. Start first with an ordinary regulator or feedback control system, Figure 1, even though by itself it has nothing to do with these terms. As the block diagram shows, the input, which may be called the "reference" or "set point," is manually set, and is in effect the value that we want the regulator to hold.

The other significant point illustrated here is that, in the majority of regulators, the process itself is outside the regulating loop. That is, we are usually not regulating a product variable or quality directly, but some intermediate quantity such as speed, voltage or current.

In relatively recent years a few regulators have been made which actually control a product variable directly. In these cases the process has been included within the regulating loop. Tension regulators are one such example, and thickness regulators, usually referred to as automatic gage control, Figure 2, are another. As the diagram indicates, the original regulating loop is normally maintained. The new "process regulator" simply forms an additional loop outside of the first one.

As we go on to more completely automated systems, and especially to more complex processes, it becomes desirable or necessary to regulate still more process and product quantities, Figure 3. Here we have introduced another factor: data logging. Although not confined to complicated systems, data logging becomes more important on them. By data logging we are referring specifically to equipment that records numbers directly, that is, it is digital. The output can take many forms,

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such as typewritten log sheets, punched tape, etc., but is always in the form of a number or number code.

Why is data logging necessary for process variables when it was not for the machine variables? There are many reasons for applying data logging equipment, but one is most important. If we are to regulate process variables it is necessary to understand how they are related to one another and to machine variables. Data logging usually provides the best method of recording large amounts of information in such a form that it can easily be used to study a process.

This takes us to the next block shown: the computer system. While the data logging system can provide much useful information to many individuals, it does not necessarily provide the information the operator needs to optimize his process. This is because the relationships between process variables and regulator inputs may be complex, or require calculation or a high degree of memory. However, once these relationships have been learned a computer can probably be designed to perform these functions.

Figure 3 illustrates yet another function not mentioned: programming. This term is applied to any method of replacing manual inputs with predecided exactly repeatable inputs. Punched card programming is probably the most familiar example.

Aside from its inherent advantages, programming is shown here because the computer may often most easily operate by introducing small changes into a nominally fixed program. Also, in the evolution of such a completely automated system, the programming may very likely have been added first.

At this point a definition, of sorts, has been reached for programming and data logging, but data processing has not even been mentioned. This will be defined broadly, in terms of Figure 3, as encompassing either the data logging system or the computer system or both. Obviously this is a loose definition, but this is the general area referred to when this term is used.

All of these components, in various combinations,

. . . . automatic data processing equipment will furnish the information by which the necessary process equations can be developed for future regulators whose "set" points can then be automatically varied to maximize output . . . .

have been used. Up to this time, to our knowledge, the outer loop shown in Figure 3 has not been closed. This greater ring, *the "ring" of the future*, promises the next great potentiality of automation—tighter management control of process performance. Gains will come not in moving the worker farther from the process, but in putting management closer. Longer runs at best theoretical efficiency, minimum raw material utilization with output of acceptable quality—these are assignments now delegated to process supervisors who too often are using information which of necessity has up to this time been incomplete since satisfactory data accumulation techniques have not been available.

The "ring" of the future offers a method for management, facing an era of intense competition, and caught in a squeeze between costs and prices, to move forward on a logical step by step, profit oriented program to achieve optimum process performance. Lower costs and higher quality will result. In our nation's struggle to keep ahead economically, and in the individual firm's struggle to match or better his competitors, we must look to latest advances in data logging, computing and programming as they are brought together in the "ring" of the future.

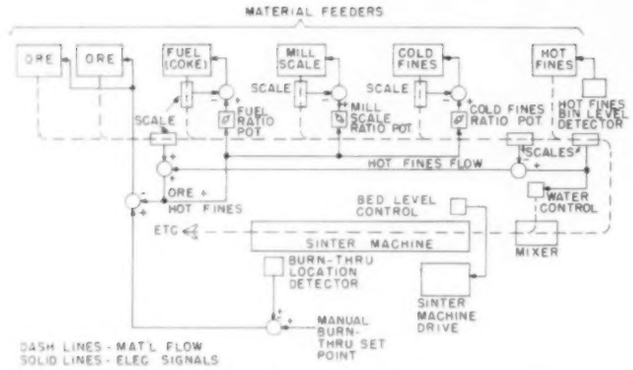


Figure 4 — Schematic diagram of sintering plant proportioning and bed level system.

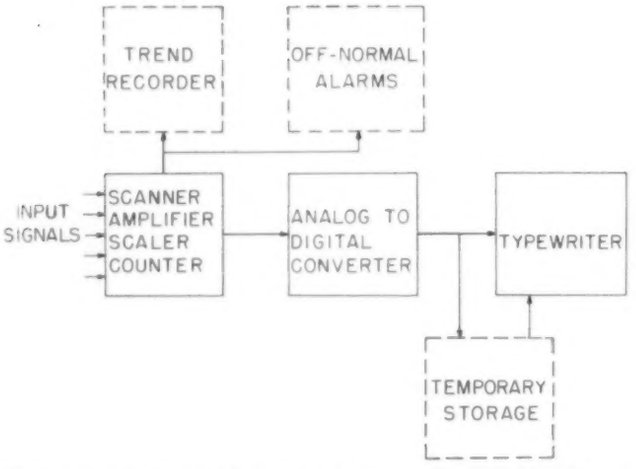


Figure 5 — One problem which must be solved before a sintering plant can be completely controlled is the formulation of process equations. These equations are formed from extensive data which must be compiled by a data logger as shown here.

SINTERING PLANT

Although sintering has gained vital importance only in recent years, considerable progress has been made toward automating it along the lines about which we have been speaking.

There are at least two major problems in the control of a sintering plant. The first is concerned with how to adjust material flow and machine speed to control bed level, burn-through point and proportions of raw materials. The problem is caused in part by the long time delays inherent in the process, Figure 4.

The conventional solution has been to use a sampling system, which is slow because of long delays inherent in it. However, a new continuous control system has been developed using computer elements and methods. Although not yet installed, in January, 1959, it was expected this new control would effect considerable improvement.

The second problem is concerned with process control to achieve highest product quality consistently, in spite of variations in raw material composition. This is a case of optimization, and requires both a computer control and a detailed knowledge of the process equations. Since these are not now known, the proper procedure is to install a data logging system, Figure 5.

This is now being done on one sintering plant. Approximately 65 measurements or input signals will be recorded at regular intervals. In addition, a readout will occur whenever an "off-normal" value occurs on any one of a group of selected inputs. It is hoped that analysis of the data logging records will provide information to enable better process control to be achieved, and ultimately to close one or more process loops through a computer.

BLAST FURNACE

The next major steelmaking process on which progress toward automation has been made is the blast furnace. The blast furnace charging system has progressed from crude hand methods to the typical semi-automatic system used today on most modern high capacity furnaces. The basic elements of this system are shown in Figure 6.

The next step taken in automating the blast furnace was to add programming of the charging cycle. Since program changes are not made frequently, pushbuttons are used rather than punched cards or other means. A typical arrangement is shown in Figure 7. There are currently at least five such programming equipments in operation. Figure 8 shows the control panel used.

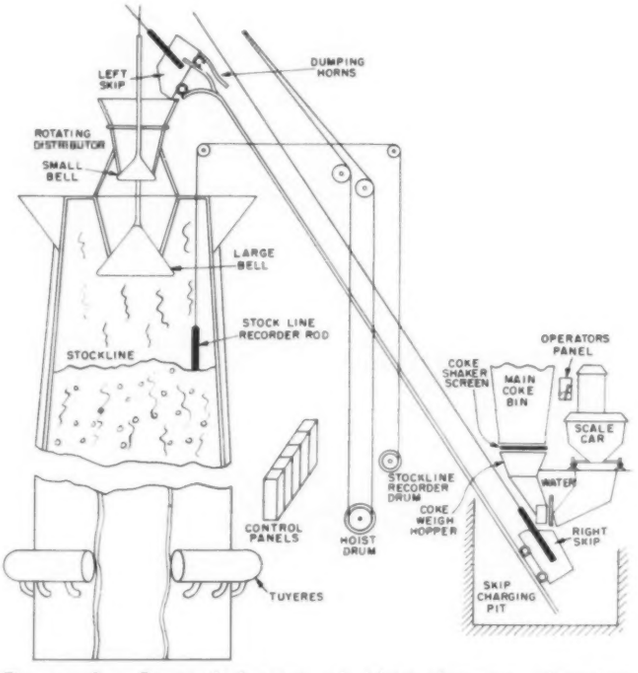
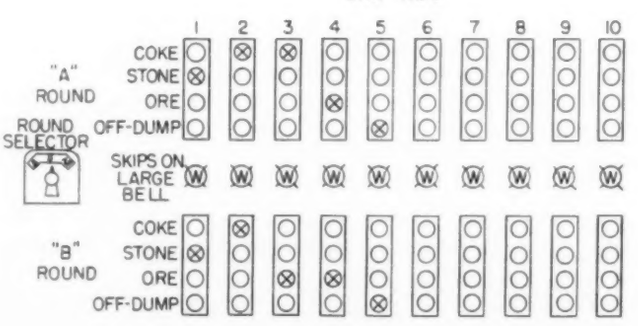


Figure 6 — General layout of blast furnace charging equipment.

Figure 7 — Because program changes are infrequently made, pushbuttons are used rather than punched cards for a blast furnace charging control.



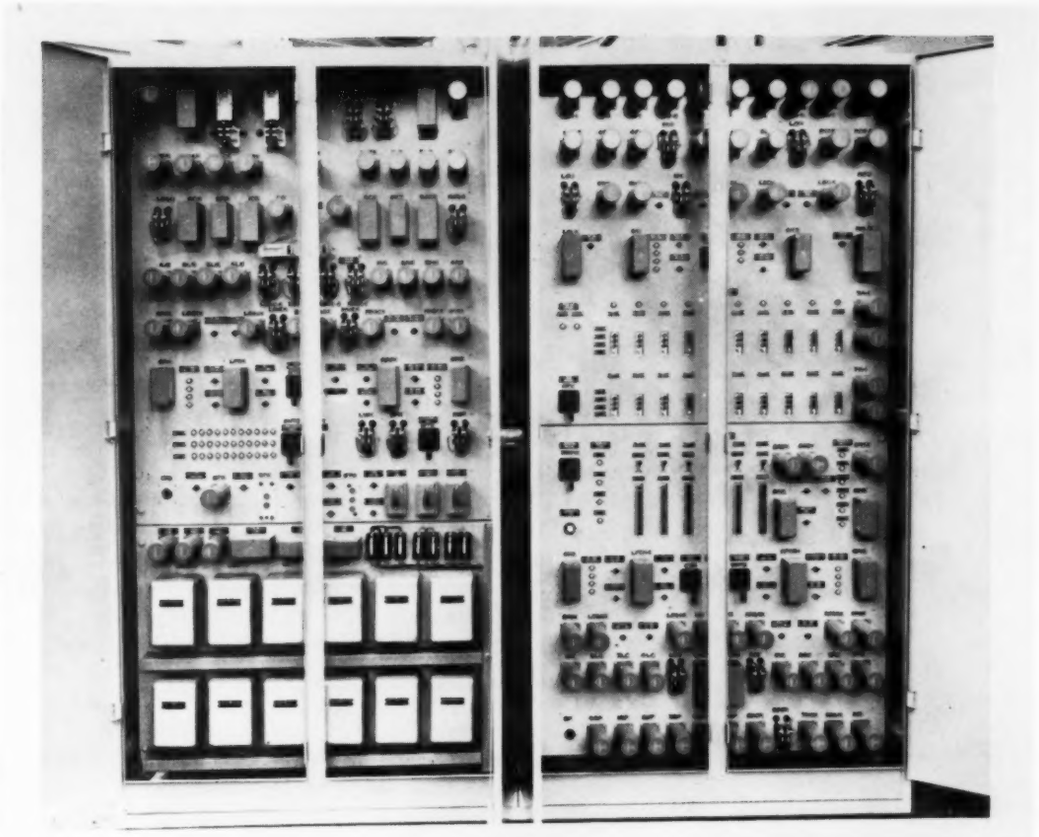


Figure 8 — Control panel of a blast furnace charging control.

Since ore and stone charges are loaded into the skip from a scale car, which requires initiation by an operator, the present system is not fully automatic. One possible arrangement that could be completely automatic is shown in Figure 9. Here each material is preweighed as is now done with coke. Then, when a skip comes to the pit, the program control automatically initiates operation of the conveyor system to charge the appropriate material into the skip, after which the charge is automatically hoisted and charged into the furnace. This system eliminates the scale car and its associated problems, and would improve furnace performance by reducing or eliminating human errors.

Still further improvements might be made by automatically changing the charging program to compensate for variations in raw material analysis. Since at least some of the process equations are known, it should be possible to design a computer to continuously modify the charging program in accordance with raw material variations, Figure 10.

The missing links in this system are suitable techniques which will provide rapid, accurate analysis of all the raw materials. Although not yet completely developed, considerable progress has been made in the area of x-ray analysis. We expect that such equipment will be available in the not too distant future.

We are not implying that these steps should be taken without installing data logging. Programming, even with a computer, is open loop control, and cannot compensate for variations that may occur in the process as a result of unrecognized variables. Data logging could provide a means for detecting and correcting for these

Figure 9 — This charging system could be made completely automatic.

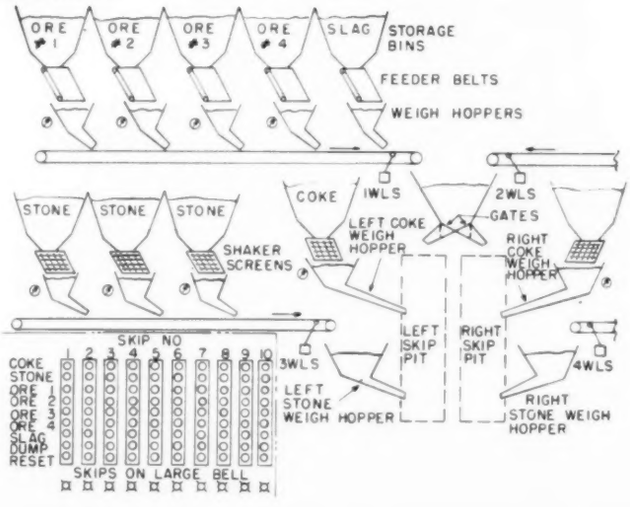
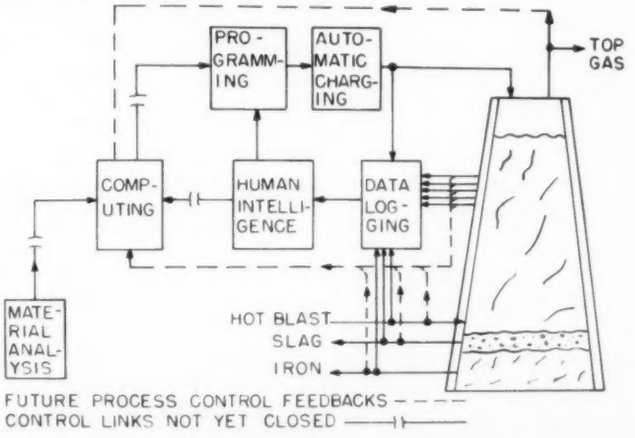


Figure 10 — The blast furnace process may be automatically optimized in the future if suitable equipment can be developed for analyzing the raw materials, which will fit into a regulating system.



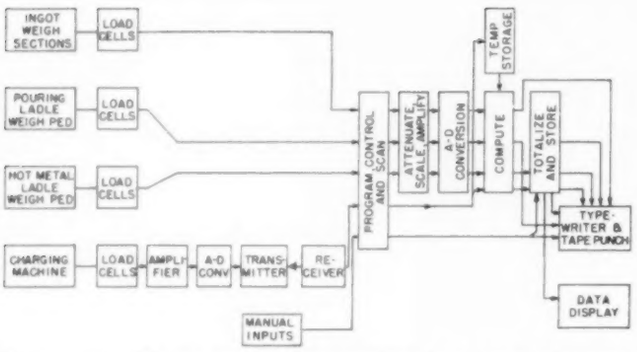


Figure 11 — This data logging system has been proposed for an open hearth.

changes, and perhaps some day closing one or more process loops.

This is getting rather far from where we are today, and yet is not far beyond what is being done elsewhere.

OPEN HEARTH FURNACE

On a par with the blast furnace in importance to the steel industry is the basic open hearth furnace, in which 80 to 85 per cent of our steel is produced. Tremendous dollar savings can result from fractional percentage improvements in efficiency. In spite of these facts, very little has been done to automate the open hearth shop.

As in so many other areas, the primary need is for more precise information. This is recognized by many steel companies, and considerable interest is being shown in data logging equipment to fill this gap. Typical of the data logging systems now being considered is the one illustrated in block diagram form in Figure 11. This system would record such data as weight and composition of dry materials charged, weight and composition of hot metal charged, weight and analysis of heat, analysis and time of slag samples, type and quantity of ladle additions, weight of each ingot poured, ladle skull weight and other pertinent data.

Because some of the required sensing devices are not presently available, some of the data will have to be manually inserted. Without a doubt the existence of such data logging systems would accelerate development of suitable sensing devices. As for blast furnaces, x-ray spectrometry and diffraction techniques hold great promise.

From the information obtained by data logging, process equations can be established to aid in the computation of theoretically correct charging practice. Completely automatic programming, and of course the closing of any loops around the process will have to wait for automatic charging equipment. As in so many other areas, the development of one phase will spur progress in other parts of the system.

REVERSING HOT MILL

In the case of reversing hot mills, as with blast furnaces, the first step toward a more completely automated process has been the addition of programming. This seems logical, since many functions may be repeated thousands of times each turn.

Punched card programming is now a generally accepted feature of these mills, and most of those ordered in the last two years have included it. In recognition of this acceptance, and the probability that card programming will be used increasingly for some time to come, a new static card reader has been designed especially for steel mill applications, Figure 12. This reader is static by all definitions of the word. That is, the card is static when read, the output is in the form of maintained signals not requiring external storage, and no contacts or other parts move during reading. All of these features are obtained by using fluorescent lamps and phototransistors for reading. The cards are read one row at a time. Thus, a parallel readout of up to 80 bits, corresponding to up to 20 decimal digits, is obtained. The readout circuits are designed to feed directly into transistor or static switching circuits.

In spite of its present status we do not mean to imply that card programming alone is the final answer. Many mills cannot use a fixed program for a given product even though the nominal entering ingot size is fixed. Variations from nominal size, temperature variations, even composition and surface may require modifications to the program.

Several methods have been considered to provide for these modifications. The first is to increase the number of stored programs sufficiently so that there is one to cover every situation likely to arise. If punched cards are the storage medium this could become ungainly. A very large number of programs could easily be stored on a magnetic drum, and made quickly available at the press of a button. This would still leave the problem of selecting the proper program for each ingot.

Another method is to make provision in the program control for manual modification, particularly of the first few passes or the last pass. This might combine the advantages of manual and programmed control, but obviously leaves much to be desired.

Remembering the solution that has been indicated for so many other processes, the logical step would seem to be to use a computer. This could either modify

Figure 12 — Static card reader for reversing mill programmer.

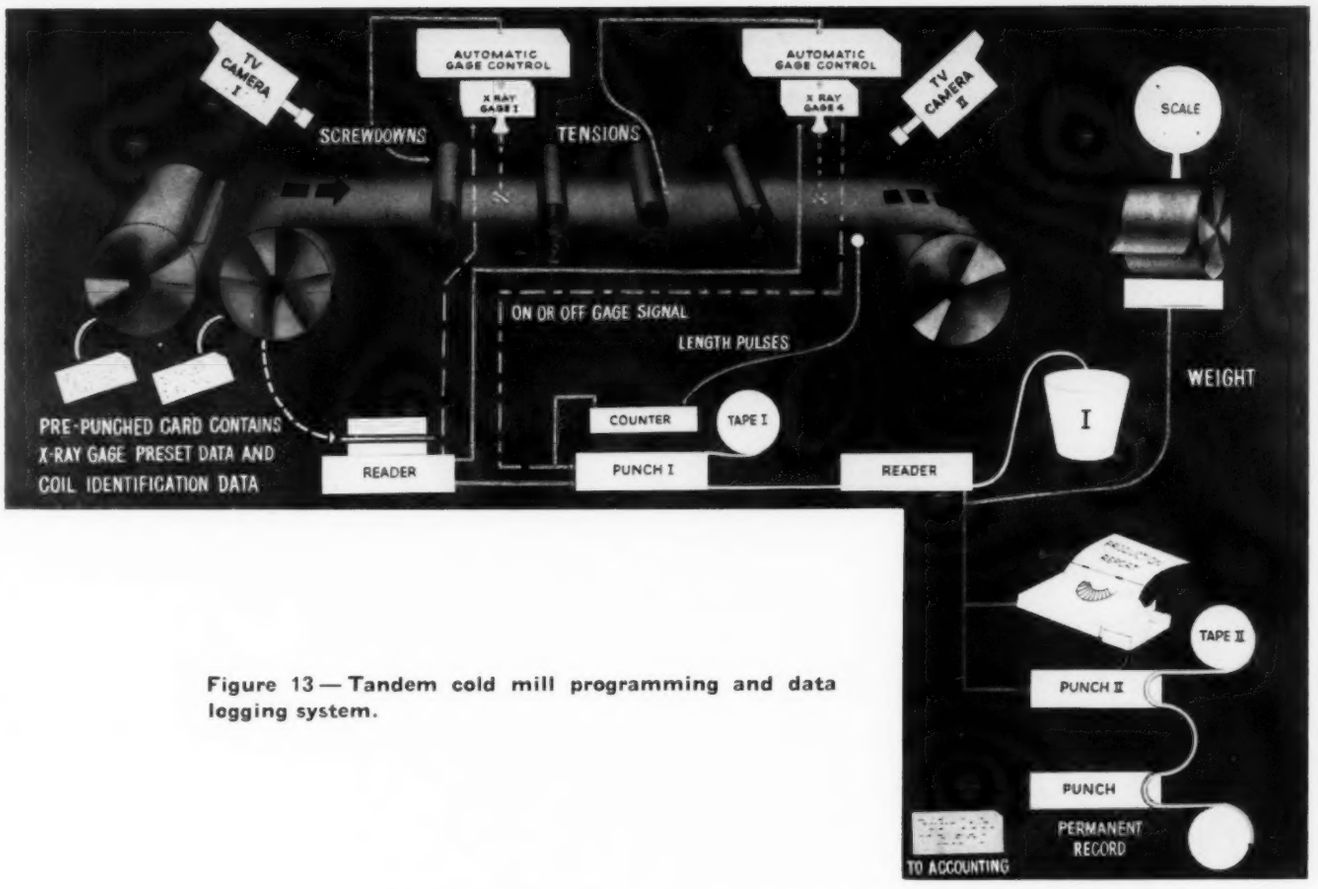


Figure 13 — Tandem cold mill programming and data logging system.

a predetermined program, or actually calculate a program step-by-step as rolling proceeded.

There is no question but that the computing techniques that would be required are available today and in use in industry. The problem is how to replace the senses and judgment of the roller. Sensing devices are either available or can be developed, but a computer cannot have judgment as we think of it in human terms. That is, it must be told ahead of time exactly what to do under any given combination of circumstances. Since this would be an extremely difficult job, we will probably choose instead to rely on empirical equations. To develop the necessary equations we once again will have to revert to data logging.

While a computer controlled reversing hot mill will be a difficult job, it does not appear to be impossible or even impractical, and work is being done in this direction.

TANDEM HOT AND COLD STRIP MILLS

After the reversing hot mill there are a large variety of processes, depending on the end product. This discussion will be confined to tinplate, not only because it is an important product, but also because more progress toward automation has been made in this field. Much of what follows is applicable to many other flat rolled products.

As was indicated at the beginning of the paper, automatic gage control is in reality a process control. These controls have been included on all new tandem cold mills purchased by the steel industry in the past two years or so. While improvements are being made, it should be safe to say that automatic gage control is now an accepted part of these mills.

Tandem hot strip mills present more difficult problems, and gage control has thus not progressed as far. However, at least one gage control system has been installed on one of these mills, and more are in process or being considered. There is little doubt that these will become an accepted—in fact necessary—part of such mills.

The next step that has been taken is the application of a programming and data logging system to a tandem cold mill, Figure 13. This system has been described before,[1]* so it will not be covered in detail here. In brief, it provides punched card programming, for two x-ray gages and gage controls, and a readout to punched tape and a typewriter of identification data, rolling times, downtimes, location of off-gage strip and coil weight.

Since this equipment has been in operation only a few months, it is too early to evaluate it. There seems little question but what the logged data will provide the knowledge necessary to improve over-all mill performance. The data collected also serves important record keeping purposes. This of course could be said of any of the data logging systems mentioned.

While this tandem cold mill installation includes programming, it does not program any functions of the mill itself. It has been designed so that programming of screws, for example, could be added, if this should prove desirable in the future. This function could be extremely worthwhile on a hot mill where there is little time between different schedules. In fact, screwdown programming, using pushbuttons, has been added to one hot strip mill. Speed programming could be added, and both could be programmed from punched cards.

* Numbers refer to appropriate reference in Bibliography.

The dollar volume of product produced on tandem mills is so great that small improvements in output can often justify expenditure of considerable sums.

ANNEALING LINES

A high proportion of the time and capital equipment required for producing strip products is tied up in heating and cooling. This is one reason for the present rapid increase in continuous annealing.

What is the optimum temperature distribution through the furnace? What causes variations in the degree of anneal obtained? How can the controls be adjusted to minimize waste caused by speed or size changes? Can computer control determine these answers and provide optimum control, as well as eliminate the need for a large number of individual controls and recorders? We hope that answers to these questions and others will be obtained from a data logging and computing system now being built for one of the steel companies. It is too early to state just what such a system can accomplish, but there is every reason to believe that the reasoning applied to other processes will be valid here.

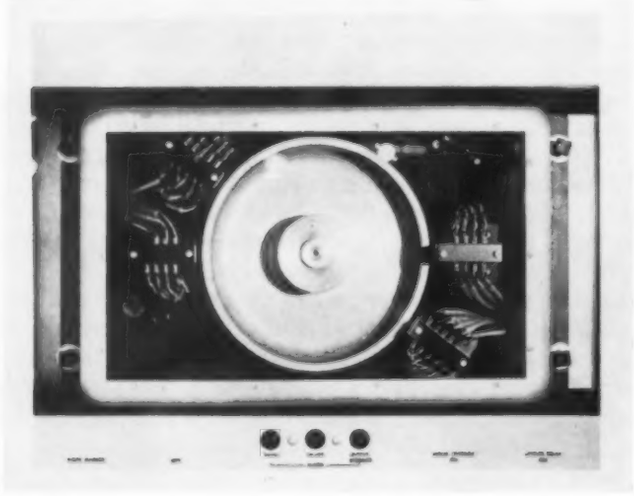
TINNING LINES

The final process to be covered is the electrolytic tinning line. The present major requirement is for means to rapidly log data, in readily usable form, on strip quality. This need is occasioned by the trend toward shipping tinplate in coil form, direct from the tinning line.

One such system has been previously described.[1] Although this equipment has just recently gone into service, several other improved systems are now under construction.[2]

The most important improvement has been the use of a magnetic drum, Figure 14. This one relatively small and simple device, in conjunction with a minimum amount of transistor circuitry, provides the functions of a shift register to bring the signals into correspondence with the strip, counters for each of the various defects and a buffer storage for the total counts during readout.

Figure 14 — This 8-in. diam, 2-in. long magnetic drum provides a shift register to bring the signals into correspondence with the strip, provides counters for each of the defects, and a buffer storage for the total counts during readout.



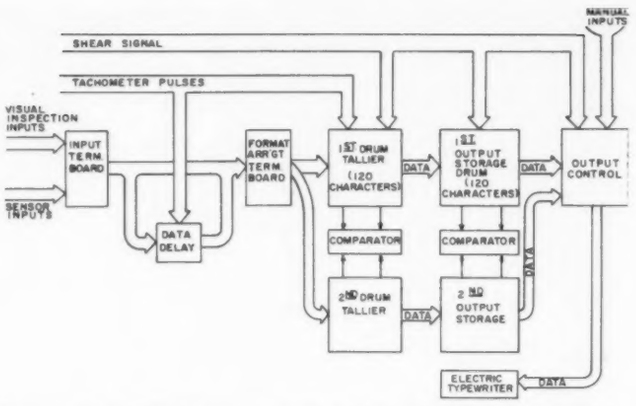


Figure 15 — Block diagram of automatic tinplate inspection data processing equipment.

In addition to greatly simplifying the circuitry, the magnetic drum provides many other improvements. For example, with very little additional circuitry it makes it possible to provide dual channels, Figure 15, for counting and storage, with continuous cross-checking. If a failure occurs in one channel, the information is not lost, and the defective channel can be repaired while the other one is in use. This should virtually eliminate downtimes due to equipment failure.

This same drum, incidentally, is used in both the sintering plant and annealing line data loggers and computers mentioned earlier. It is such a versatile device that we predict it will find its way into many more data processing systems in the steel industry.

PLANNING FOR THE "RING" OF THE FUTURE

The discussion of devices and techniques for data processing have been intentionally minimized. This is a rapidly changing field in which it is very difficult for those not specializing in it to keep well informed. The users should understand enough of devices and techniques to judge their suitability to the job to be done, their relative reliability and ease of maintenance and their flexibility for the modifications that will inevitably be required in such a new field.

On the other hand, it is most important that the users, who are naturally the most familiar with their processes and problems, be aware of the kinds of jobs these techniques are capable of performing, and be constantly alert to places they can be used to advantage. The joint efforts of the steel mills and the electrical manufacturers can keep up with the ever increasing needs for higher production and lower costs.

By the proper application of available electrical data processing and programming equipment to steel mill equipments, a step by step, logical approach to the "ring" of the future will develop throughout the mill. Areas of automation will develop, each working toward an over-all system to include the entire steel plant. Such a system will enable efficient management control, allowing decisions to be based on up-to-date information.

BIBLIOGRAPHY

1. "Automatic Numerical Data Logging and Processing in the Steel Industry" by R. M. Sills and G. E. Terwilliger, 1958 Proceedings AISE, p. 835.

2. "An Automatic Numerical Data Logging System for Tinplate Lines" by G. E. Terwilliger, AIEE Conference Paper CP-58-1399, presented at February, 1959, General Meeting. ▲

TENTATIVE PROGRAM

Association of Iron and Steel Engineers
1959 Annual Convention

HOTEL SHERMAN CHICAGO, ILL.

SEPTEMBER 28, 29, 30, OCTOBER 1

TENTATIVE PROGRAM

Association of Iron and Steel Engineers

1959 Convention

HOTEL SHERMAN CHICAGO, ILLINOIS

SEPTEMBER 28, 29, 30, OCTOBER 1

MONDAY, SEPTEMBER 28

9:00 am—REGISTRATION—
Old Chicago Room

9:15 am—BUSINESS MEETING—
Louis XVI Room

Conducted by President Emil Kern

9:30 am—ELECTRICAL SESSION—
Louis XVI Room

Chairmen: R. J. Beeswy, Superintendent, Electrical Dept., Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

John F. Kostelac, Assistant Electrical Superintendent, Midland Works, Crucible Steel Co. of America, Midland, Pa.

"Feedback Automatic Gage Control for Hot Strip Mills," by T. H. Bloodworth, Chief Systems Engineer, Electrical Application Dept., E. H. Christian, Engineer, and J. H. Stoltz, Engineer, Metal Working Section, Control Dept., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

"Electrical Power Demand Regulating System at Geneva Works," by W. H. Strate, General Supervisor—Electrical Engineering, Geneva Works, Columbia-Geneva Steel Div., United States Steel Corp., Provo, Utah

"Electronic Maintenance Training at Allegheny Ludlum Steel Corp.," by James C. Haube, Supervisor, Training and Maintenance, Electro-Mechanisms Dept., Allegheny Ludlum Steel Corp., Brackenridge, Pa.

9:30 am—COMBUSTION SESSION—
Crystal Room

Chairmen: David Cousley, Assistant Superintendent Utilities, Steubenville Works, Wheeling Steel Corp., Steubenville, Ohio

Charles W. Dunn, Superintendent Utilities Dept., Fairless Works, United States Steel Corp., Fairless Hills, Pa.

"Automatic Control Systems for Gas Mixing Stations," by J. K. Sazavsky, Chief Application Engineer, GPE Controls, Inc., Chicago, Ill.

"Expansion of Inland's No. 3 Open Hearth Shop," by Richard G. Phelps, Manager, Steel Production, Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

"Increased Open Hearth Production with the Use of Oxygen," by T. A. Thompson, Assistant Superintendent Open Hearth, Weirton Steel Co., Div. of National Steel Corp., Weirton, W. Va.

2:00 pm—OPERATING PRACTICE SESSION—
Louis XVI Room

Chairmen: H. A. Long, General Manager Operations, Pittsburgh Steel Co., Monessen, Pa.

Stephen Vajda, Staff Process Design Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"Some Applications of Computer Control in the Iron and Steel Industry," by Dr. T. M. Stout, Manager, and Dr. S. M. Roberts, Process Analyst, Process Analysis Dept., The Thompson-Ramo-Wooldridge Products Co., Beverly Hills, Calif.

"Powder Lancing in Steel Mill Operations," by C. B. Milton, Project Engineer, Development Laboratory, Linde Co., Newark, N. J., and L. F. Keel, Engineering Service Representative, Linde Co., Pittsburgh, Pa.

"Economic Forecasting in the Steel Industry," by R. D. Woodward, Analyst for Commercial Research and Industrial Development, Bethlehem Steel Co., Bethlehem, Pa.

2:00 pm—MECHANICAL SESSION—
Crystal Room

Chairmen: C. H. Good, Jr., Chief Engineer—Central Operations, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

G. M. Kyle, Assistant Superintendent, Mechanical Dept., Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

"Fairless Works, Sheet and Tin Division, Industrial Wastes Treatment," by William A. Sech, Technical Coordinator, Maintenance and Utilities Div., Fairless Works, United States Steel Corp., Fairless Hills, Pa.

"Hard Surfacing Blast Furnace Bells, Hoppers, Etc.," by Roger Fluck, Assistant Superintendent, Weldment Dept., and Charles W. Dunn, Welding Supervisor, Bethlehem Steel Co., Bethlehem, Pa.

"Automatic Charging System for Assembling and Handling Raw Materials at the Blast Furnace," by John F. Meissner, President, John F. Meissner Engineers, Inc., Chicago, Ill.

TUESDAY, SEPTEMBER 29

9:00 am—ELECTRICAL SESSION— Louis XVI Room

Chairmen: H. W. Dorset, Assistant Superintendent, Electrical Dept., Bethlehem Steel Co., Sparrows Point, Md.

R. G. Nolan, Electrical Engineer, Granite City Steel Co., Granite City, Ill.

"Continuous Annealing Line Drive Systems," by Richard M. Bosshardt, Application Engineer, Reliance Electric & Engineering Co., Cleveland, Ohio

"The Application of the Mercury Arc Rectifier to Large Reversing Mill Drives," by M. B. Antrim, Manager, Engineering-Construction, Lukens Steel Co., Coatesville, Pa.

"Performance Characteristics of a Rectifier Powered Plate Mill," by C. E. Rettig, Manager, Rectifier Circuit Development, General Electric Co., Philadelphia, Pa., and J. E. Peebles, Steel Mill Application Engineer, Metal Rolling & Processing Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

9:00 am—COMBUSTION SESSION— Crystal Room

Chairmen: W. M. Bloom, Senior Engineer—Fuel, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

F. C. McGough, Superintendent, Fuel and Power, The Youngstown Sheet and Tube Co., East Chicago, Ind.

"Basic Refractories—1959," by Mervin A. Fay, Manager, Basic Sales, General Refractories Co., Philadelphia, Pa.

"Experiences with Basic Open Hearth Roofs," by Howard Parker, Division Superintendent, Steel Products, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

"Technology of Basic Brick," by George R. Eusner, Division Chief—Refractory and Mineral Technology Div., Applied Research Laboratory, United States Steel Corp., Monroeville, Pa.

2:00 pm—OPERATING PRACTICE SESSION— Louis XVI Room

Chairmen: C. W. Bruce, Chief Engineer, Steel Plants, Republic Steel Corp., Cleveland, Ohio

H. L. Jenter, Vice President—Operations, American Steel & Wire Div., United States Steel Corp., Cleveland, Ohio

"The Evolution of the Iron and Steel Industry in South Africa," by Dr. C. M. Krüger, General Manager, South African Iron and Steel Industrial Corp., Ltd. Pretoria, South Africa

"Some Comparisons Between German and American Steelmaking Practices," by Director Dr.-Ing. Erich Kemna, Vice President, DEMAG Aktiengesellschaft, Duisburg, Germany

"Problems in Engineering the 1955–1958 Inland Steel Co. Expansion Program," by Irwin Rosenak, Chief Engineer, Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

2:00 pm—LUBRICATION SESSION— Crystal Room

Chairmen: Charles Bailey, Lubrication Engineer, National Tube Div., United States Steel Corp., Pittsburgh, Pa.

T. A. Bessent, Lubrication Engineer, Bethlehem Steel Co., Sparrows Point, Md.

"Spray Lubrication of Roll Necks," by Alfred A. Paul, Manager, Engineering—Sales, The Brooks Oil Co., Cleveland, Ohio

"The Selection and Use of a Water Soluble Rolling Oil," by Paul W. Coffman, Assistant General Superintendent, Riverdale Plant, Acme Steel Co., Chicago, Ill.

"Lubrication of Republic's 45-In. Slab Mill," by Walter J. Rodenberger, Lubrication Engineer, Cleveland District, Republic Steel Corp., Cleveland, Ohio

6:00 pm—OLD TIMERS DINNER— Crystal Room

WEDNESDAY, SEPTEMBER 30

9:00 am—ELECTRICAL SESSION— Louis XVI Room

Chairmen: J. A. Drgon, Division Superintendent, Maintenance & Utilities, Edgar Thomson Works, United States Steel Corp., Braddock, Pa.

Clayton L. Squier, Assistant Electrical Superintendent, Bethlehem Steel Co., Lackawanna, N. Y.

"The Blooming Mill Programmed!" by H. G. Frostick, General Supervisor, Design Engineering, New Mills Construction, South Works, United States Steel Corp., Chicago, Ill.; A. W. Smith, Jr., Engineer in Charge of Development, Metal Working Section, Industrial Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.; and Marshall Brittain, Manager, Co-ordinated Digital Development, Systems Control Engineering Dept., Westinghouse Electric Corp., Buffalo, N. Y.

"Inland's New Automatic Slabber," by R. J. Beeswy, Superintendent, Electrical Dept., and E. R. McGaughey, Superintendent, No. 3 Blooming & No. 4 Slabbing Mills, Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

"Is the Fault Always Electrical?" by R. J. Byrnes, Senior Electrical Engineer, Cutler-Hammer Inc., Milwaukee, Wis.

9:00 am—LUBRICATION SESSION— Crystal Room

Chairmen: Norman A. Bracht, Lubrication Engineer, Alan Wood Steel Co., Conshohocken, Pa.

C. T. Lewis, Chief Lubrication Engineer, Republic Steel Corp., Cleveland, Ohio

"Design Data for Bearings of Nylon, Acetal, and TFE Fluorocarbon Resins," by L. H. Gillespie, Applications Technologist, and G. S. Hudson, Sales Technologist, Sales Service Laboratory, Polychemicals Dept., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

"Making Lubrication More Effective as a Weapon in Management's War on Wear," by Wayne G. Ritter, President, Ritter Engineering Co., Pittsburgh, Pa.

"Filtration in the Iron and Steel Industry," by John R. McCoy, Manager, Technical Service, Indiana Commercial Filters Corp., Lebanon, Ind.

2:00 pm—OPERATING PRACTICE SESSION— Louis XVI Room

Chairmen: William O. Bishop, Superintendent Plant No. 2 Blast Furnaces, Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

Clyde A. Roberts, Jr., Chief Engineer, Structural Div., Phoenix Steel Corp., Phoenixville, Pa.

"Blowing Methods in Steelmaking," by G. M. Yocom, Assistant to General Manager, and L. Xidis, Steubenville Works, Wheeling Steel Corp., Steubenville, Ohio

"Filtering Air for Steel Mills," by C. D. Wright, Steel Mill Application Specialist, Air Filter Div., American Air Filter Co. Inc., Louisville, Ky.

"Experience in Cleaning Blast Furnace Gas with the Orifice Washer," by G. E. Reid, Utility Engineer, Steam Efficiency & Combustion Dept., Pittsburgh Works Div., Jones & Laughlin Steel Corp., Pittsburgh, Pa.

2:00 pm—ROLLING MILL SESSION—
Crystal Room

Chairmen: D. C. Horsman, Plant Superintendent, Continental Steel Corp., Kokomo, Ind.

R. P. Schuler, Manager, North Mills, Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

"Material and Design Defects in Forged Steel Rolls," by A. A. Bradd, Coordinator of Rolls, Midvale-Heppenstall Co., Nicetown, Philadelphia, Pa.

"Sandwich Rolling," by H. S. Orr, Project Development Engineer, Rolling Mills, United States Steel Corp., Pittsburgh, Pa., and Frank R. Romeo, General Foreman, Sheet and Stainless, Homestead District Works, United States Steel Corp., Munhall, Pa.

"Salient Features of Armco's New Hot Strip Mill, Butler Works," by Cyril H. Roberts, Supervising Mechanical Engineer, and Thomas M. Kilgo, Senior Electrical Engineer, Butler Works, Armco Steel Corp., Butler, Pa.

7:00 pm—FORMAL DINNER—Ball Room

10:00 pm—DANCE—Ball Room

THURSDAY, OCTOBER 1

8:30 am—INSPECTION TRIP—

To Indiana Harbor Works, Inland Steel Co., East Chicago, Ind. Buses for the Inspection Trip will leave from the Hotel Sherman.

Trip will cover important facilities of the plant, particularly those installed since the War. Trip is restricted to citizens of the United States and Canada. No ladies are permitted.

A limit of 500 is set for the trip. Priority on tickets will be given in the order that ticket applications are received. Checks must accompany trip reservations.

LADIES PROGRAM

Ladies Headquarters and Registration—
Parlor L Hotel Sherman

Monday, September 28....Coffee—9 am to 12 m
Parlor L
Hotel Sherman

Tea—3 pm
Yacht Club

Tuesday, September 29....Luncheon 12:30 pm
The Kungsholm

Honorary Chairwoman: Mrs. Emil Kern

Honorary Vice Chairwoman: Mrs. E. O. Krueger

General Chairwoman: Mrs. F. H. Gill

Assistant General Chairwoman: Mrs. R. E. Dubois

To partially cover costs, a flat registration charge of $5.00 will be made which will cover all ladies activities except the formal dinner on Wednesday evening. This must be paid on registering, when tickets will be issued for these events.

AISE Annual Convention will be held regardless of steel strike status. In the event the strike is on, the inspection trip through Inland Steel Co. will be cancelled. If the strike is settled and the plants are just starting up at the time of the Convention, status of trip will be announced at the convention.

Chicago skyline looking northwest from Lake Michigan

Figure 1 — Over-all view of No. 2 piercer from entry side at new automatic seamless mill at Sault Ste. Marie, Ontario.

Recent Developments In Pipe And Tube Mill Machinery

by Dieter Hancke, Vice President—Sales

and Robert Hartenstein, Vice President—Engineering, Mannesmann-Meer, Inc., Youngstown, Ohio

TO the somewhat careless spectator, it must seem that today the tube industry is living in a rather dull age. While in other fields of metal forming and rolling continuous processes turn out products at fantastic speeds, pipe is still made by three basic and comparatively slow methods, two of which are also necessarily discontinuous—the old reliable piercing process and the method of piercing and subsequent extrusion of solid billets into pipe—while the third process, tube welding, has only rather recently begun to deserve the classification of being truly continuous.

This fact is certainly very disconcerting for young and ambitious engineers and operators who dream of nothing less than the invention of an entirely new process for making tubes. One can, of course, not claim that it is impossible. The facts, however, do not bear out a high rate of probability of such revolutionary ideas to be substantiated—rotary piercing of solid billets came about in 1886, extrusion of solid billets was tried as early as 1836, the automatic plug mill was born in 1903, the first pilger mill was operated in 1892, the first attempt at what today is called continuous rolling over a mandrel bar was made in 1889, the first push bench was built in 1892 and it is an accepted fact that forming and brazing of strip into pipe and subsequent cold drawing was done long before the first seamless shell was ever pierced.

New developments in the fields of seamless tube and stretch reducing mills and pipe finishing equipment merit consideration in design of new mills and for modernization of old units.

Since the glorious 90's, therefore, development in the tube industry has pretty much been a continuous re-application of known principles in a variety of combinations and with an ever-increasing degree of refinement rather than a succession of revolutionary steps from new process to new process.

Despite the fact that piercing mills today may appear pretty much like their 35-year-old predecessors, quite a few design improvements have gone into them. Not only do they pack more power relatively to roll diameters and billet size for higher piercing speeds, but they have also been designed all over for fast size changes, pass setup and tool changes. Figure 1 is an over-all view of No. 2 piercer from the entry side at a new automatic seamless mill at Sault Ste. Marie, Ontario. In this presentation, however, it is not intended to stress the various features of this type of piercing

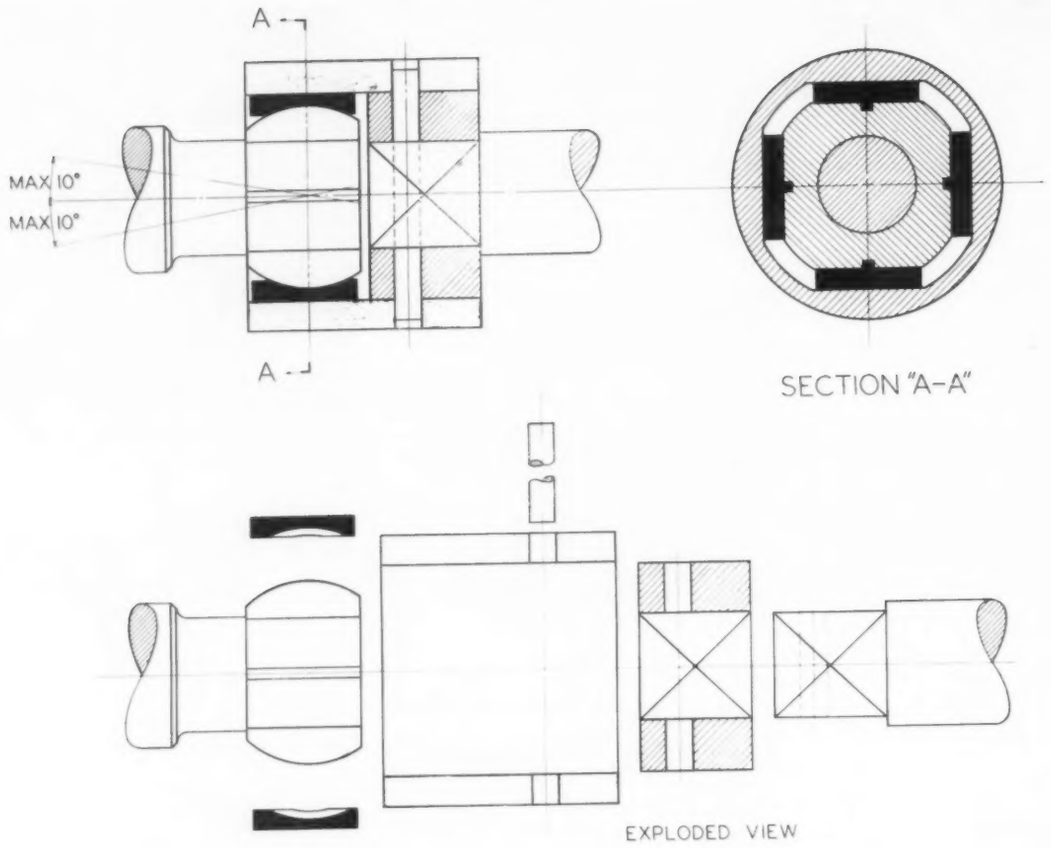


Figure 2—An assembly and exploded view of a piercing mill universal joint spindle coupling.

mill but rather to deal with a specific point of piercing mill design. From both the designer's and operator's point of view it is highly desirable to have a piercer spindle coupling which permits the rolls of the mill to be dressed down to an economical minimum size and still to be able to pierce the smallest size billet as well as a coupling which permits rapid changing of the slipper brasses and quick disengagement for roll assembly changes. The conventional spade type coupling design has certain limitations with respect to each of these points. Figure 2 shows in assembly and in an exploded view the type of coupling used on both piercers at Mannesmann Tube Co. The body of the coupling arbor is machined from forged steel and welded to the spindle shaft. The coupling head has four semi-cylindrical surfaces which are 90 degrees opposed to each other. These surfaces are hardened and mount four slipper brasses which on the inside match the coupling head and on the outside bear flat against the inner surface of the coupling sleeve. Slippers can be changed simply by pulling the locking pin and sliding the coupling sleeve back over the spindle shaft. All slippers are individually lubricated from the point of spindle support. The relative size of this coupling versus a spade coupling can best be conceived by comparing mentally the components of the coupling with the spindle shaft diameter.

The torque capacity at 99 rpm with a 4000-hp 300 per cent pull-out torque synchronous motor against 32-in. minimum roll diameter is 480,000 ft-lb at an outside diameter of 26 in. This type of coupling has also been successfully used on pilger mills and plug mills.

For many years tube mill designers have considered the desirability of a single groove plug mill whereby it would be possible to change the entire mill against a second one which was previously setup in a manner similar to that used on sizing and reducing mills. The first of such plug mills is installed at Mannesmann Tube Co. at Sault Ste. Marie and incorporates many features unknown to the conventional plug mill.

As can be partially seen in Figure 3 this mill consists of a heavy cast steel C-frame designed to mount 2-roll carriers on horizontal shafts through the main body of the frame. The bottom roll is fixed in its elevation relationship by spacers and hydraulic cylinders whereas the top roll is normally held in the up or pass-open position by separate hydraulic cylinders. The closing of the pass is accomplished by an air cylinder actuating a cam and forcing the top roll down against its hydraulic system.

Each of the rolls is independently driven by its own 2250-hp d-c motor with a speed range from 70 to 160 rpm providing the mill with its basic production feature, namely, acceleration. In other words, the mill "hooks in" at a base speed of approximately 90 rpm and then, with the pipe in the rolls, accelerates to a maximum rolling speed of 160 rpm. This cuts the total rolling time for pass No. 2 on API length Range III to approximately two seconds.

The stripper rolls of this mill are also mounted in a C-frame type interchangeable stand which as in the case of the main stand is anchored to the mill base by hydraulic wedging devices. The combination of C-frames and hydraulic wedges permits the rapid interchange of stands with those previously setup on the floor in an anticipated time of approximately 30 minutes.

To keep within this size changing time the mandrel

bed of the mill consists of V-shaped troughs actuated by a wedge system for size setup purposes and a hydraulically actuated lever system to facilitate opening of the top guides for bar changes.

On the receiving table of the mill, a new device for indexing the pipe 90 degrees between passes is provided. This equipment consists of three stands of cross rolls which are individually driven and moved into and out of the inlet trough by air cylinders. These units have also contributed substantially to the over-all reduction in rolling time, which has finally shifted the production bottleneck away from the plug mill.

Of the recent improvements in reeler design most features are common with the piercing mill developments. In one respect, however, the reelers at Mannesmann Tube Co., which are shown here in Figure 4, differ considerably from previous designs. The individual roll drive, which has been pioneered in Europe on reelers and even on small piercing mills, employs commercial universal joint spindles with anti-friction bearing cross joints. Each roll is driven from its lower end by a 400-hp, 720-rpm synchronous motor with an intermediate gear reducer. In the more than one year of operation of this equipment, drives and spindles have required no maintenance whatsoever, and it is expected that the use of individual reeler roll drives will set a pattern for American mills.

Hot sizing mills also have come a long way in the past years. Figure 5 shows the 7-stand sizing mill at Mannesmann Tube Co. for rolling seamless casing and line pipe from 4½ to 10¾ in. diameter. The C-frame type design permits the provision of a mechanical stand changing device for use when roll stands have to be removed or interchanged for mill schedule changes. In essence, the rolls are mounted and alined in their individual stands on the floor in preparation for operation. Then the stands are loaded on a truck which transports them to a position in line with their respective places in the mill. The stand changing device then pushes all stands into the mill frame on machined guide ways by providing common lateral motion. The gear couplings for all horizontal roll drive spindles automatically engage during the last portion of the stand travel. Then hydraulic latches clamp the stands solidly to the mill frame while air cylinders lower the gear coupling halves of the vertical roll drive spindles into place. All stands are herewith lined up, requiring no further adjustment, and the mill is ready for operation.

The reverse procedure is used for removing roll stands from the mill, and it is of course possible to change all or any combination of stands. The total time required to execute any given size change is less than 30 minutes.

Figure 6 shows another sizing mill which has gone into operation recently. This mill also has seven stands and is driven by individual 100-hp, 575 to 1150-rpm d-c motors to roll seamless pipe and heavy wall mechanical tubular products from 3 to 8 in. diameter. The arrangement of the drive spindles from the rear and from above makes all gear boxes easily accessible and keeps water, scale and other annoying matter such as grease and oil away from all drive components. This mill again is provided with the fast stand changing device and self-alining stand positioning. The roll screwdown is effected by interconnected eccentric roll neck bearing

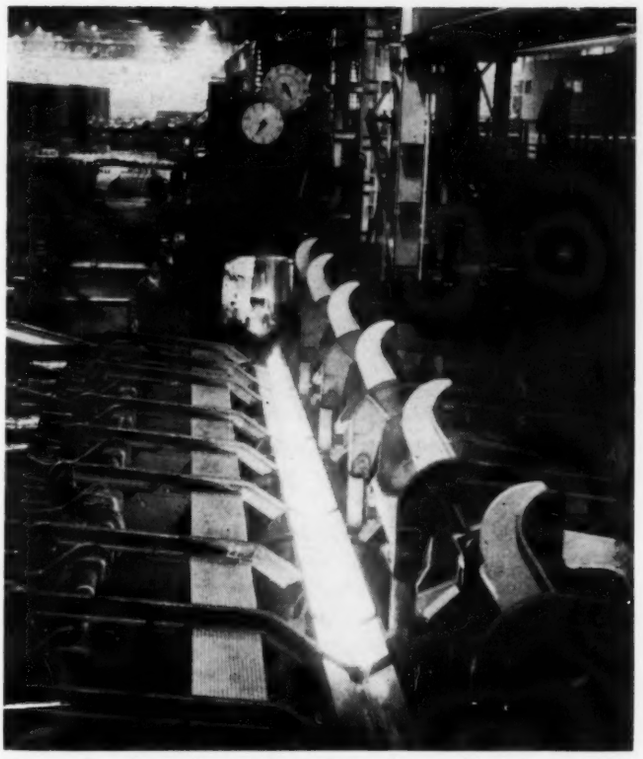


Figure 3 — On this single-groove plug mill it is possible to change the entire mill with a second one which is previously set up in a manner similar to that used on sizing and reducing mills.

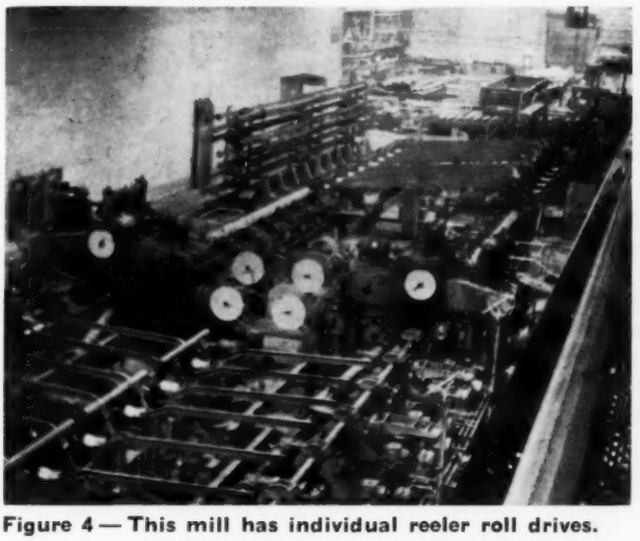
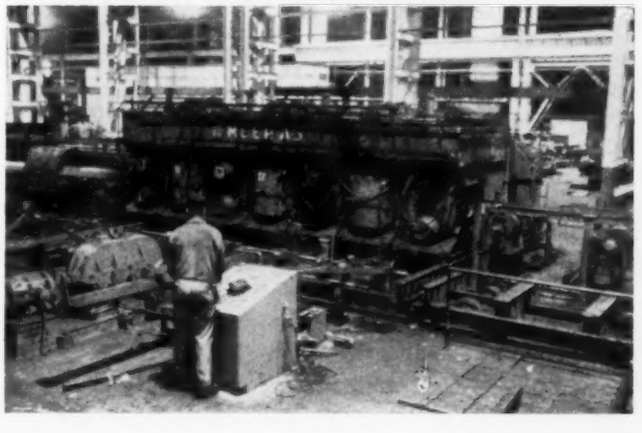


Figure 4 — This mill has individual reeler roll drives.

Figure 5 — This 7-stand sizing mill rolls seamless casing and line pipe from 4½ to 10¾ in. diameter.



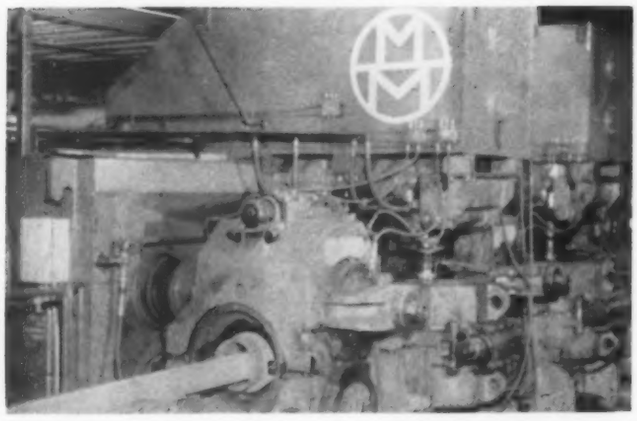


Figure 6 — Seven-stand mill with individual motors to roll seamless pipe and heavy wall mechanical tubular products.

sleeves such that no matter how many pass adjustments the operator makes, the mill alinement is positively maintained.

The familiar typical C-frame design with the stand changing device and automatic stand coupling and alinement is recognizable in Figure 7 which shows a 12-stand 3-roll type reducing mill with 12-in. roll diameter and 12-in. stand spacing. The mill is used to handle a highly irregular schedule pattern of various types of seamless tubing from 3½-in. maximum diameter in going to about 1-in. finished diameter. Figure 7 shows the unusually close stand spacing and how the roll stands are clamped hydraulically from an above forward direction to provide automatic pass alinement.

The installation at Lone Star Steel Co. is the advent of the combination of stretch reducing mill and electric resistance weld mill in this country. More than five years of operating experience with this type of combination in Europe have shown that fully normalized electric weld pipe can be produced at rates and at cost figures equivalent to the most advanced continuous butt weld mills. In fact, the consistently growing number of installations of this type has pretty much taken over the field. There are now eight plants operating in Europe and one in Mexico, and at least three new installations are under way, and this all in the size range from ⅜ to 4 in. which has been an almost exclusive domain of the continuous butt weld mill.

Lone Star Steel Co.'s new stretch reducing mill is yet another step forward since it does project the conception of continuous production into the field of larger diameters and, quite more important, into the field of high product quality, in Lone Star's case API casing, line pipe and tubing. The inherently high production capacity of the electric resistance welder, particularly for high quality pipe, can be explored to its full extent only under the following conditions:

1. Since welding speed at given transformer capacity is a function of wall thickness, maximum tonnage output is equivalent to the largest pipe diameter.
2. The larger in diameter the pipe, the easier a good job of inside flash removal can be done.
3. Since frequent or even occasional size changes not only mean considerable downtime for tooling change, but also result in a certain start-up and adjustment period afterward before an optimum weld is attained, there should be as few size changes as possible.

If one recognizes these conditions, one can immediately stipulate that everything which permits the welder to be operated continuously, eight hours a turn, at the largest possible size, with the heaviest possible wall and with no size changes whatsoever, must result in lowest possible conversion cost and the highest possible product quality. Now this is precisely what the stretch reducing mill does. In Lone Star's case this stretch reducing mill can reduce 5⅝ x 0.244-in. wall to 2⅜ x 0.190-in. wall, or 6⅝ x 0.265-in. wall to 2⅜ x 0.190-in. wall, or 5⅝ x 0.188-in. wall to 2⅜ x 0.154-in. wall, with still some reserves left for wall corrections. Any size change, even those involving all stands, can be executed in less than 30 minutes, and the first pipe leaving the mill after the performance of a size change is right there where the wall belongs.

Figure 8 shows this stretch reducing mill. The 3-roll stand assemblies are easily recognizable. The C-frame design permits the arrangement of the mechanical stand changing device in front of the mill and provides visibility and exceptional accessibility to the mill. The exact positioning of the stands in the mill frame and the coupling procedure between roll stands and mill drive is fully automatic and takes place with the operation of the stand changing device. It may be pointed out that this mill leaves only the stand speeds for the operator to play with—alinement comes with the C-frame design, and there is no roll adjustment whatsoever.

Operational results of the hydro-mechanical mill drive has fulfilled all promises. These include the

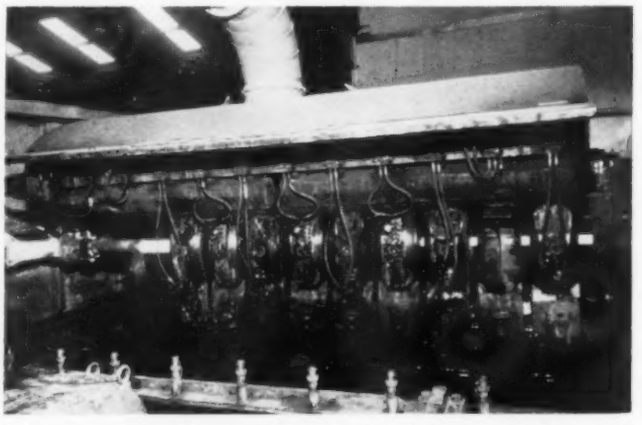
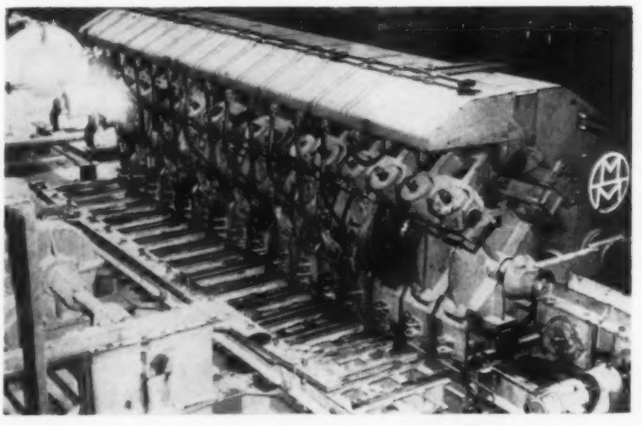


Figure 7 — The 12 stands of this 3-roll type reducing mill are spaced only 12 in. apart.

Figure 8 — Size changes are executed in not more than 30 minutes on the stretch-reducing mill.



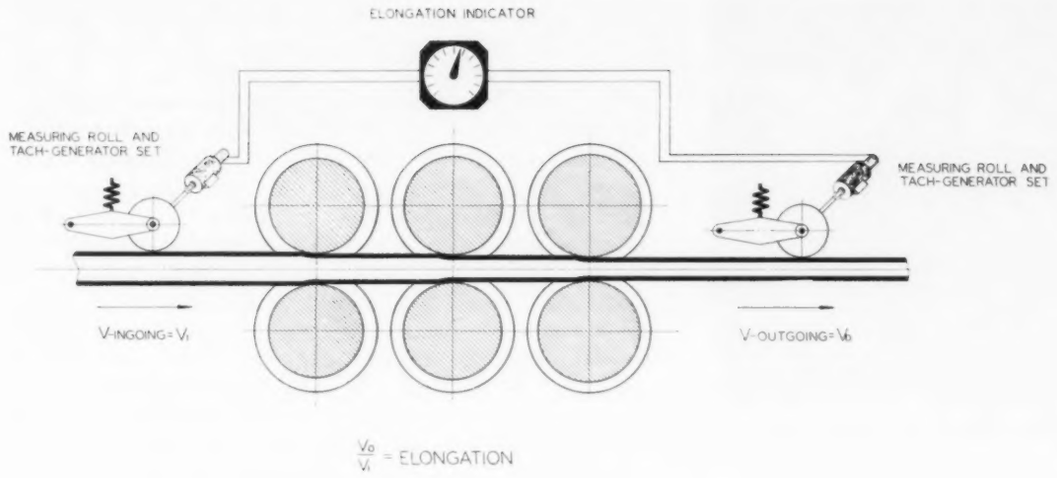


Figure 9 — Schematic drawing of elongation measuring device.

absence of practically any maintenance of the hydraulic units. However, one unique characteristic of this drive deserves to be again commented on because it offered the possibility of fully exploring the advantages of a newly developed device which does provide a constant and accurate wall reading of the stretch-reduced pipe during the rolling process.

Strip mill operators appreciate the help they get from x-ray gages which furnish them constant on-the-spot information of what in effect they are doing on their mill. So far, such a device was missing in the tube industry which was particularly distressing on fast continuous butt weld mills and other semi-continuous stretch mill operations where tons of off-gage wall pipe can be produced before one even knows that something is wrong.

Some steps have been taken recently to apply x-ray gages to pipe and to get an average wall reading. The way, however, in which this problem was tackled at Lone Star Steel's stretch reducing mill, is so simple that one is almost ashamed to pass it off as a development. Figure 9 shows a sketch of what is called an elongation measuring device. If ingoing diameter, ingoing wall and outgoing diameter are known, then the measured elongation of the pipe in the stretch reducing mill must produce the outgoing wall thickness. The whole thing is done by feeding tach-generator signals from two measuring wheels immediately ahead of and behind the mill into a differential instrument which indicates elongation or, if desired, wall thickness directly. The mill operator now has two push buttons with which he can—according to the instrument reading—increase or decrease the over-all speed ratio progression of all mill stands, and so bring his elongation to exactly where it ought to be—this all, of course, while the pipe is in the mill. This so-called co-adjustment of all stand speeds is a by-product of the hydro-mechanical mill drive, and it is not entirely inconceivable to equip the differential elongation indicator with two contacts, set a permissible wall tolerance, wire the contacts into the co-adjustment, and have a self-regulating mill.

Unavoidably, there are, of course, certain limitations to the production capacity of the combination of welder and stretch reducing mill. Every foot increase in welding speed produces a considerable headache for the equipment designer. Not that the stretch reducing mill is limited in speed—quite contrary, more speed is desirable since it means less spread of physical properties and deformation inefficiency throughout the mill because of less temperature differential. But the pipe leaving the mill has to be cut on the fly. And the flying saw is the true bottleneck of the whole affair.

Now, almost all of us are familiar with the development of flying saws for continuous butt-weld mills during recent years which have made possible delivery speeds in excess of 1200 fpm out of the reducing mill portion of the continuous weld mill. This, in itself, is an excellent achievement which deserves to be highly complimented. Unfortunately, semi-continuous operation of stretch reducing mills—and such is the case with all seamless or welding mills with the sole exception of continuous weld mills—provides an added inconvenience in the form of the desirability of cutting not only when pipe is there, but also of being ready to cut whenever the pipe emerges out of the mill, which is, of course, rather unpredictable.

Without wanting to stipulate ready-made conclusions, it is, however, obvious that the problem of dealing with speed alone has led to the design of continuously running flying saws which are, consequently, highly sensitive to speed fluctuations of the pipe to be cut and particularly to all interruptions of the continuous operation on which their design concept is based. This results in a certain inaccuracy of the repetitive length of cut and a totally unpredictable location of the first cut on a pipe which just comes out of the stretch mill. A solution of the problem to design a saw which could efficiently cope with speed fluctuations and discontinuity had, therefore, to be sought on the other tack. The flying saw at Lone Star Steel Co. is an example of this new design concept. This type of flying saw operates discontinuously, that means, it stops completely after each cut and starts for the next cut whenever the signal is given. Highly accurate measuring of pipe speed and continuous speed signal transmission assure instantaneous reaction of the rectifier control for the saw carriage drive to any speed variation or fluctuation, and the signal for any cut—front end or full length—is given by the pipe itself. This means that the portion of pipe which has passed under the saw before the saw starts for the cut has, in effect, been measured in length from the centerline of the saw to the position of the cut signal limit switch in the saw outlet conveyor

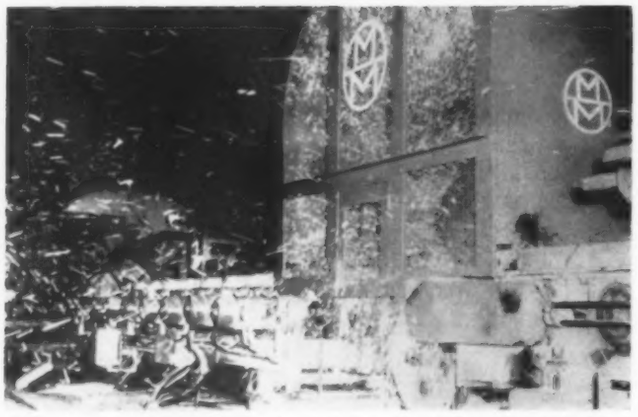
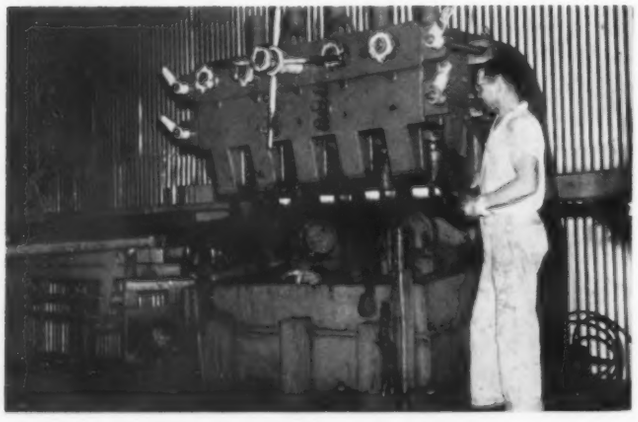


Figure 10 — This saw at Lone Star Steel Co. is rated 700-fpm top speed.

when the signal for the saw to start for the cut is given. This then, in turn, means that any deviation in time from the predetermined fraction of a second, which is necessary to accelerate the saw downward for the cut, will have an influence only on the portion of pipe which passes under the saw during this acceleration time, and that, since this portion of pipe is only a fraction of the total length to be cut off, the accuracy of length of cut is inherently very high with this type of saw. Although the saw at Lone Star Steel Co., which is shown in Figure 10, is rated at 700-fpm top speed, a number of similar saws in other installations abroad operate at top speeds in excess of 1200 fpm with a repetitive accuracy of cut of plus, minus $\frac{1}{4}$ in. regardless of the length of cut. This is, of course, also valid for the front crop end which can be cut at any desired length. The length of cut is variable during operation, and the quality of cut in combination with the accuracy in length is such that API tubing, for instance, can go right to the upsetter, and that standard pipe needs only to be chamfered before being processed on multiple tube testers at the rate of six or eight tubes at a time.

There have been some new advances in the field of cold working of tubes. One of these developments came about quite by accident when it was discovered that a rotary straightener of a design which in itself is about ten years old is excellently suited for rotary straightening of tubing with externally upset ends. This operation has been performed for some time in the tube industry in a rather left-handed fashion on straighteners of the well known design which employs two driven rolls and

Figure 11 — A 60-hp, 2-speed motor drives this 165/330-fpm straightener.



three opposed idler rolls, all of hyperbolical shape. To let the upset ends pass through this straightener, the two idler rolls, which are opposite of the two driven rolls, had to be retracted so that the actual straightening was performed by only three rolls in an arrangement similar to the way the platens are positioned on a straightening press. Because of the absence of the guiding effect of the two retracted rolls, the idler pressure roll had to be set much more into the pass line to accomplish any deformation exceeding the yield point. As a result, the tubing goes through the straightener "banana" fashion, and, particularly on vertical straighteners, gets away from the inlet and outlet table by going into the straightener downhill and coming out uphill. This results in excessive whipping of the ingoing unstraightened position and therefore imposes a limitation on straightening speed. At the same time, it was found that a rather high number of the tubing thus straightened required another straightening pass involving inconvenient additional material handling and a further limitation of the number of pieces straightened in any given time.

The vertical rotary straightener used now for straightening of both upset and plain end tubing has seven skewed rolls of which the two lower rolls are driven, and five idling pressure rolls are arranged in-line opposing the lower rolls. The straightener shown in Figure 11 has a size range from $\frac{3}{4}$ to 4-in. outside diameter and is driven by a 60-hp 2-speed motor with straightening speeds of 165 and 330 fpm. Externally upset API and other tubing from $2\frac{7}{8}$ in. size on down has been successfully straightened in one pass operation with an average of 4 per cent reject for restraightening because of upset end hooks not being fully eliminated.

Figure 12 shows how, on this type of straightener, the rolls are arranged. Diagram A shows the standard arrangement when straightening plain end pipe. The tube is subjected to three peak bending moments each of which can be adjusted to just exceed the yield point. Diagram B shows the roll arrangement when straightening upset tubing. The retraction of both guide rolls to let the upset ends pass does not in any way influence the threefold straightening action. Contrary to the 3-roll arrangement described before, the tube goes into the straightener uphill and leaves it downhill, therefore having positive contact with approach and outlet table and consequently running very smoothly without any whipping. Diagram C shows how the upset end threads its way through the straightener, and shows also the limitations of size range imposed by the condition that the total length of the upset portion of the pipe must not exceed the center distance of the rolls.

Since all five top rolls are interconnected to a common point of screwdown adjustment, and since the angularity adjustment for each top roll in relation to its vertical position is automatic and built into the screwdown arrangement, straightener setup for any given size is very easy. Each top roll can, of course, be disconnected from the common screwdown arrangement for individual adjustment when necessary.

The 3-roll design of reducing mills, which was described before in this paper, has made two successful debuts in the cold reduction of steel pipe. One mill, with three stands, as shown in Figure 13, is used for resizing seamless pipe after heat treatment. The mill

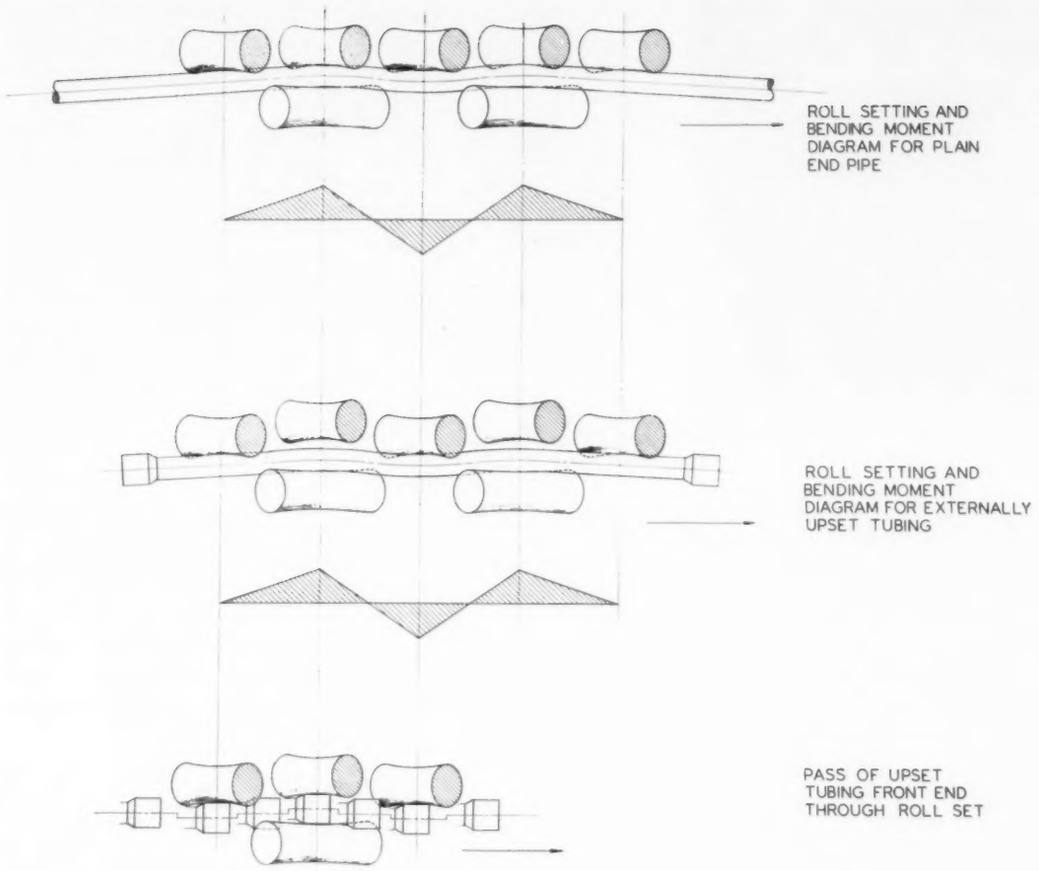

ROLL SETTING AND BENDING MOMENT DIAGRAM FOR PLAIN END PIPE
ROLL SETTING AND BENDING MOMENT DIAGRAM FOR EXTERNALLY UPSET TUBING
PASS OF UPSET TUBING FRONT END THROUGH ROLL SET

Figure 12 — Schematic diagram of operation of 7-roll, vertical straightener on plain end pipe and externally upset tubing.

has 24-in. diameter rolls in three stands spaced 24 in. apart and can cold size up to 10¾ in. diameter pipe with yield strengths of 120,000 psi and higher. The 3-roll design, having no roll adjustment, permits very rigid roll neck bearing construction which is important because of the high compression forces necessary for cold reduction. The mill is equipped with the fast size change device described before which allows one to exchange all roll stands and to be ready again for operation in less than 20 minutes.

A solidly geared drive with automatic roll stand couplings and a 225-hp, a-c induction motor provides rolling speeds from 100 fpm for 10¾ in. pipe to 145 fpm for 2⅜ in. tubing.

Another mill of the same basic design principle is employed for the cold reduction of tubing. This mill has five stands of the 3-roll design with 16-in. roll diameter, the stands being spaced 16-in. apart. Hardened alloy steel rolls are used, which are ground in the same fashion as chilled cast iron rolls are machined for standard reducing and stretch reducing mill practice. Here again, the mill is not long enough in operation yet to have reliable roll life data available. The total diameter reduction accomplished on this mill is in excess of 3 per cent. Five individual variable speed d-c motors with a total of 900 hp permit cold rolling of 2⅜ in. tubing with 60,000-psi yield strength at speeds of approximately 600 fpm. It is expected that the close stand spacing, together with the positive stand alinement and the absence of any possibility of roll adjustment provided with this type of mill, will substantially shorten the front end hooks which are common with conventional cold sizing mills and will, therefore, result in a material reduction of yield losses.

A rather decisive step forward has been made in another field of cold reduction of steel and nonferrous tubing. Everyone who ever had any dealings with tube reducers or, as they are called in Europe, with cold pilger mills, has had pretty much the same thought when looking at the tube coming out of these machines: "If they would only go faster!" Today they do go faster, in fact, about twice as fast. The prototype of such a cold pilger mill with a mechanically compensated drive has been in operation for a little more than two years, mostly on stainless steels, and since then, eleven more cold pilger mills in the sizes 2½, 3½ and 4½ in. plus one 6½ in. and one 8½-in. machine with this drive, went into operation or have been delivered. These machines are running at speeds of 180 cycles per minute for the 2½ and 3½ in. mill and at 150 cycles per

Figure 13 — This 3-roll reducing mill is used for resizing seamless pipe after heat treatment.

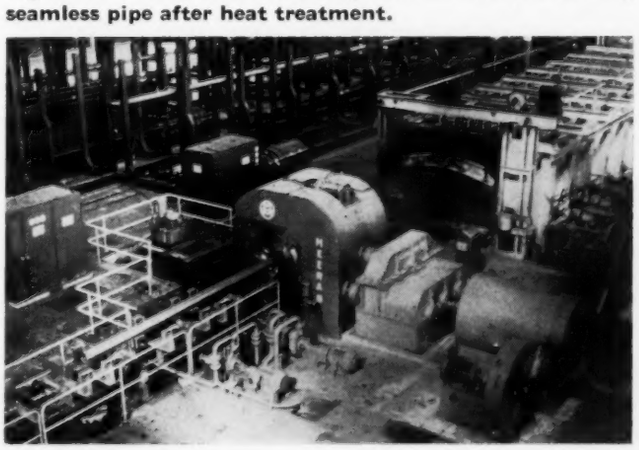


Figure 14—This prototype 2½-in. mill has a compensated drive.

minute for the 4½ in. mill. The 8½ in. mill is designed for 70 cycles per minute and there is little doubt that it will run at that speed. Further refinements are expected to bring the 2½ and 3½-in. machines into the 200 cycle per minute range.

Figure 14 shows the prototype machine, a 2½-in. mill, with the compensated drive, consisting of two reciprocating masses opposing the roll housing which are connected to the crankshaft at points approximately 90 degrees off-set against the connecting rods which move the roll housing. Figure 15 shows parts of the approach table and the feeding and turning mechanism of a 4½-in. mechanically compensated machine.

In eyeing the obvious result of this design, that is, the much higher operating speed and therefore higher output and reduced production costs, one must not overlook a probably equally important gain. The compensation of the rolling forces and the comparatively much higher acceleration and deceleration forces with their annoying habit of reversing twice for every cycle could be accomplished in a way which produced an always positive flow of power from the drive into the machine. This elimination of torque reversal finally enabled the designer to extricate himself from the vicious problem cycle of higher speed resulting in more inertia, resulting in higher forces, resulting in more maintenance, requiring heavier design, with higher masses and therefore reduction in speed—and so on repeatedly. The result is a surprisingly heavy machine operating at high speed accompanied by the drastic cut in maintenance requirements which has been so long awaited by cold pilger mill operators. An indication of what is going on in these new machines is provided by the drive ratings—the 2½-in. machine comes with a 175-hp motor, the 3½-in. machine with a 300-hp motor, the 4½-in. machine with a 400-hp motor, the 6½-in. machine with a 600-hp motor and the 8½-in. machine with a 1000-hp motor. The design problems of feeding and turning at such speeds have been very satisfactorily solved. It will be interesting to know that no metallurgical difficulties have been encountered at this speed step-up, although one cannot truthfully call this cold rolling any longer. Material temperatures on experimental runs have been in the 800-F range on the 2½-in. machine when rolling stainless steel with standard cooling.

Figure 15 — Parts of the approach table and the feeding and turning mechanism of a 4½ in. mechanically compensated machine.

Sufficient cooling lowered the temperature to about 500 F. The behavior of the material and its deformation properties have not been influenced in any way by the higher speed with the exception of the front ends of high alloy steel shells, which have shown a tendency to split longitudinally when not preheated to actual rolling temperature. When preheating could not be provided, a temporary reduction in rolling speed until the front end has passed through the dies has done the trick.

Cold drawing of steel and nonferrous tubing has undergone quite some development in the two recent decades. A 1938 drawbench today looks rather old-fashioned alongside a modern multiple drawbench with fully automatic carriage and tube loading equipment. Yet another interesting contribution has been made to the art of cold drawing—the cable type drawbench. The prototype, a 22,000-lb single drawbench for 30 ft-0 in. length of draw, has been in operation for over two years in Germany. The first bench of this type in operation in this country is a 5-draw 20,000-lb bench with 90 ft-0 in. length of draw, 300-fpm maximum draw speed and 450-fpm carriage return speed. The bench is driven by a 125-hp reversible d-c motor with a speed range from 575 to 1440 rpm which in turn is powered by a 125-kw variable voltage motor-generator set with automatic cycle control.

Figures 16 and 17 show how the carriage is securely fastened to a dual set of wire rope cables, one on each side of the draw bench. The draw cables are wound around two drums which are mounted on the double output shafts of a worm gear reducer. The return cables are led around two idler sheaves at the die stand and are then fastened to the cable drums. When the carriage moves toward the die stand, the draw cables unwind from the drum and the return cables wind right into the drum grooves which were just vacated by the draw cables, and vice versa. The dual cable arrangement permits the tube to be discharged by gravity onto sloped skids after completion of draw and therefore eliminates skid arms which are always a maintenance headache on fast drawbenches. The point of cable connection to the carriage is, of course, right on the centerline of draw and therefore eliminates any tilting forces on the carriage. Both cables are prestressed by a tension device on the independently mounted idler sheaves, the amount of preload being equivalent to or higher than the rated pull of the bench. The cables will therefore not lengthen when load is applied, which results in a surprisingly

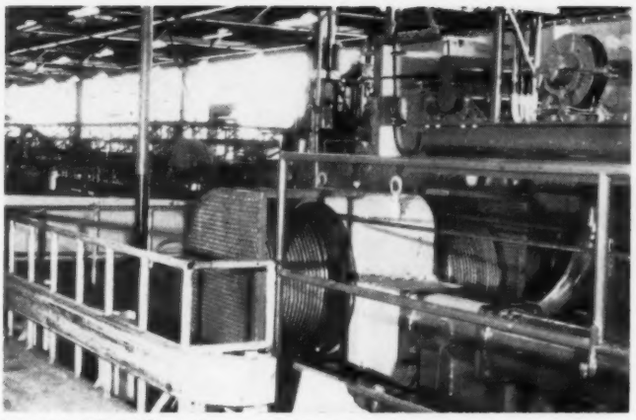


Figure 16 — The draw cables of a drawbench are wound around two drums which are mounted on the double output shafts of a worm gear reducer.

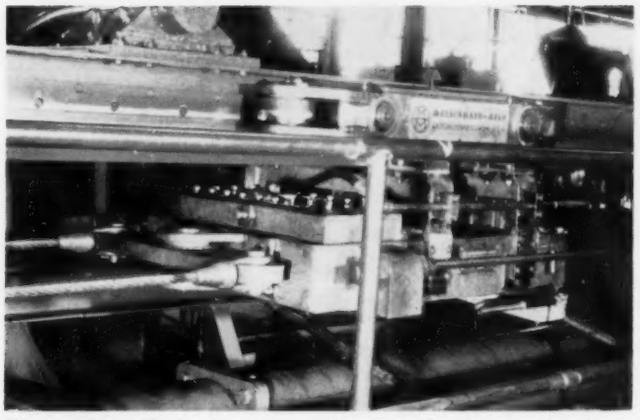


Figure 17 — This view of a drawbench shows the draw cables and their connection to the carriage.

smooth operation of the bench. Furthermore, because of a special differential spring and hydraulic shock absorber design for tube and gripper jaws, and because of the complete absence of generation of vibration and shatter which is contrary to chain benches where the chain articulates around the sprockets at a fluctuating angular velocity, this type of draw bench produces virtually no hook on the pointed end of the tube. Runs with ½ x 0.035-in. wall 90 ft-0 in. long copper tubing have proved this point for the preloaded cable arrangement. The positive control of the carriage at all times provides an excellent possibility for fully automatic operation with sharply reduced time between draws. Time studies show that the production capacity of this type of bench is anywhere from 110 to 125 per cent of that of a single-chain type bench when compared under equivalent conditions. There is also some indication that the complete absence of generation of primary vibrations and of resonance to secondary vibrations such as die shatter will permit considerably higher draw speeds than have been known up to now.

It can be said that continuous and detailed efforts to improve performance in operation and to reduce size change and maintenance delays on tube and pipe mill equipment have led to some interesting designs which, the authors are convinced, deserve consideration not only in the planning of new complete mills but are equally well suited to be used in the modernization of existing facilities. ▲

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EOT CRANES AT STELCO

. . . . AISE crane specifications have met with international acceptance and wide usage both within and without the steel industry . . . . present studies on revising the AISE Specifications for Electric Overhead Traveling Cranes for Steel Mill Service, AISE Standard No. 6, make the following paper very timely . . . . some suggestions merit careful consideration by the AISE crane committee . . . . other suggestions advocate standardization probably to a much greater degree than can be included in an overall industry specification such as AISE Standard No. 6, but do merit consideration as company standards . . . .

"DESIGN, CONSTRUCTION AND MAINTENANCE"

by John Witts

Crane Design Engineer

The Steel Co. of Canada, Ltd.

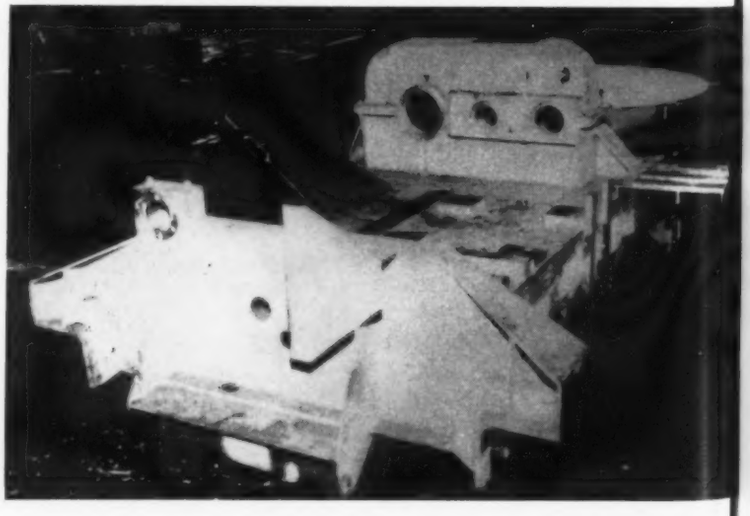
Hamilton, Ontario, Canada

THE Association of Iron and Steel Engineers has, since 1910, sponsored a series of specifications defining the design requirements of cranes for steel mill service. At the Steel Co. of Canada, AISE Specification No. 6 is used in conjunction with our own, the latter having been evolved from the experience of our operating, maintenance and engineering departments. Methods of design, installation and general requirements differ from, and disagree in some instances with AISE Standard No. 6. This paper tells of some of these Stelco features; it is in essence applied engineering.

Regardless of how good a crane design specification is, it is wise to acknowledge that the final product, and its performance, are also dependent upon the machining, fabrication and assembly practices of the builder. Before it is possible to properly and fairly evaluate a crane price proposal, it is necessary to know the builder, his machine tool capacity, welding procedures and assembly practices. Some will line machine and bore trolley frames, end trucks, etc., others are dependent on weldments and shims for proper alinement. It is these differences which govern price and quality and often they cannot be controlled by a specification. The practice of selecting a builder on the sole basis of price or cost per pound is foolish to say the least. Figure 1 shows a welded trolley frame before assembly.

A crane is judged by its performance because it is often an essential step in a production sequence and its lifting capacity and travel speeds must be such that they match the production speeds of the mill. Sometimes this is overlooked, and more attention is focused on the way in which it is built rather than why it was built. Lifting capacity and hoisting speeds are quite easy to define, but bridge and trolley speeds are not. When stating the latter it is not sufficient to merely state them in terms of feet per minute. It is more accurate to state a definite acceleration requirement, or state the speed in terms of distance traveled from rest, or the speed after so many seconds have elapsed. When buying a crane it is often a mistake to copy its specification from those of an existing crane, in many instances

Figure 1 — This is a welded trolley frame before assembly.



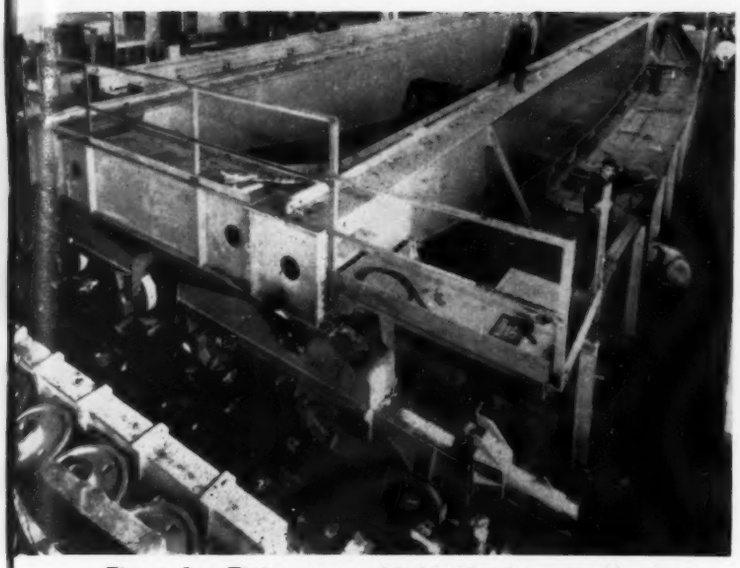


Figure 2 — Eighty-ton welded bridge in assembly shop.

the calculated speeds stated in the specification differ from the actual speeds. When compiling a crane data sheet state the measured speeds and wheel loads. The actual and theoretical wheel loads can vary by as much as 30 per cent. Runway failures often puzzled us until we started to measure wheel loads. This was done by using hydraulic jacks and pressure gages. Figure 2 shows a 80-ton welded bridge being built for Stelco.

The design layout does not involve a great amount of engineering. Sometimes a crane maintenance man can check a layout and make a better arrangement than an engineer. The crane may have only two hours downtime a week and may be in service approximately 40 years, during which time maintenance costs could be high and the amount invested in unused spare parts excessive. The average price of a mill crane installed is approximately $250,000 and may require that an additional $35,000 be spent on mechanical spare parts of which a large percentage may never be used but which must be kept on hand. In a plant having almost 200 cranes this means a vast amount of money invested in spares and our aim is to diminish this investment. The following suggestions are worthy of consideration during the initial design of a crane. They can often result in a saving of money and increased reliability.

1. *Relocating cranes*—Having established a need for new cranes in a particular area consideration should be given to existing cranes within the company. There may be cranes suitable for this new project which are at present being overloaded, or are not fast enough in their present location, in which case, the economical procedure is to switch locations, and to make this simpler we are standardizing crane spans and rail sizes. There is no reason why an old or slow mill crane should not be utilized if needed in a motor room or machine shop.

2. *Mechanical components*—Here standardization is very important, and since machine design is not an exact science, corresponding parts on different cranes can be duplicated and it matters little if the design stresses are lower than required or the bearing sizes exceed requirements. Standard rail sizes, track wheels, axle boxes, line shafting (both in length and diameter), line shaft bearings, couplings, cable sheaves and hooks are used. M. R. Bowerman and E. R. Madison, in their paper, "Standardized Component Parts For Heavy Duty Mill Type Cranes," AISE Yearly Proceedings, 1958, give excellent examples of what can be achieved. Cranes built by Stelco would, if possible, have standardized gear boxes, end trucks and drive layouts, and the girders which are riveted would be designed to our standard layout thus saving both time and money. Although we have built cranes, it is not our intention to become crane builders.

It has been a shortage of time which prompted us to do this work, usually when a crane was taken out of service either because of old age or damage. During the last plant expansion money was saved on spare parts due to duplication of sub-assemblies on a group of cranes. This practice tends to limit us to one crane manufacturer. However, in the future we will undertake the design of parts which can be duplicated. This work will be done with the co-operation of a group of manufacturers and will enable us to purchase cranes from anyone and still have interchangeable parts. This can apply to wheel and bearing assemblies, hook block assemblies, hoist drums and some drive assemblies. Figure 3 shows part of a standard Stelco crane.

3. *Trolley layout*—Quite a large percentage of mill cranes have two hoists, the main hoist capacity being approximately twice the capacity of the auxiliary and, in most instances, it is possible to have the auxiliary

Figure 3 — Attempts are made to standardize layout of equipment on cranes.

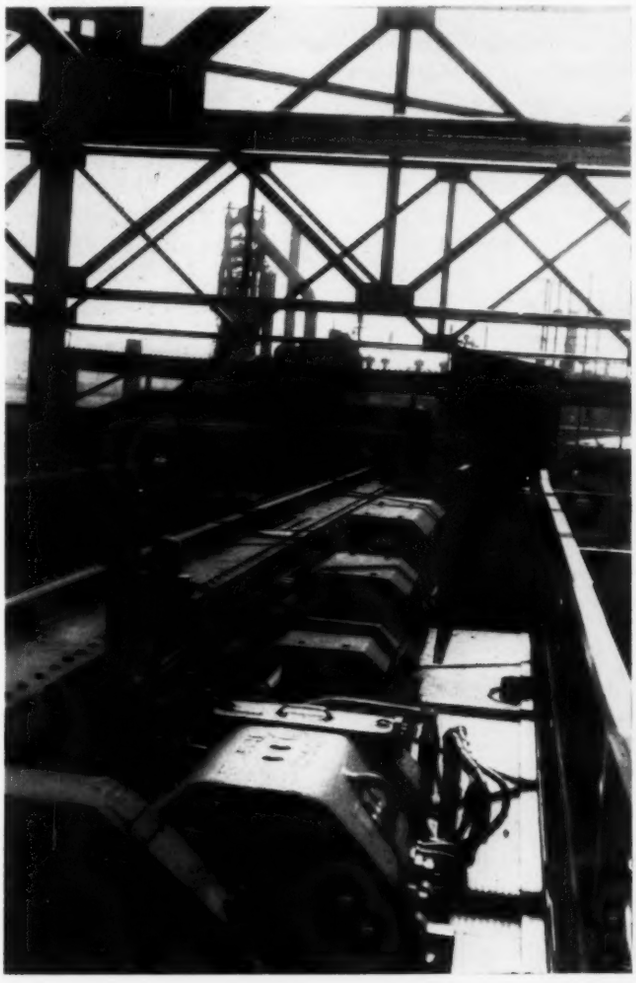


Figure 4 — View of hoists and cab of a 50/30-ton crane.

hoist lifting speed double that of the main hoist. If this is so, then the main hoist can be supported by twice the number of cables as the auxiliary, and both hoist drives can be mechanically and electrically identical. The two hoist control panels may by the use of double-throw knife switches, drive either hoist motor. One complete set of electrical equipment could be dispensed with, should cost, rather than reliability, be the chief consideration. Of course, it would still be necessary to install two limit switches, resistors and load brakes. When two hoists are not in the ratio of two to one in capacity or speed, then a change in drum diameter, one pair of hoist gears or hoist reeving arrangement can give similar duplication. Frequently the duty cycle of a crane requires the 60-min motor rating to be used on one hoist, and the 30-min rating on the other, in which case, control panels may be the same even when motor frame size is different.

Having established a hoist cable size and type (6–19 or 6–37), sheaves and bearings may be duplicated. Sheaves in the top block and in the hook block should be the same, this is not always so. Hoist drums can sometimes be made the same even though in some cases it means not using all available cable grooves. Figures 4 and 5 show standard hoist arrangements.

ELECTRICAL

The normal practice is to erect and wire all cranes ourselves, purchasing the electrical equipment direct

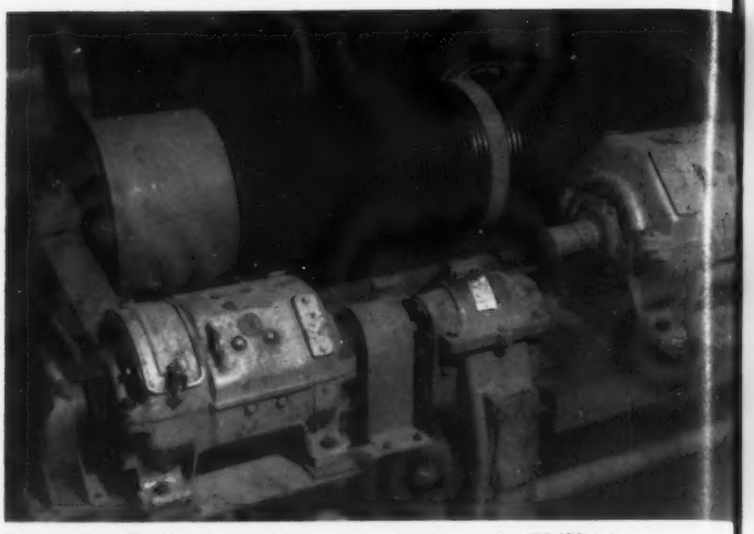


Figure 5 — Trolley machinery arrangement of a 50/30-ton crane.

from the electrical suppliers.

The only electrical conduit is that used to protect the lighting circuits. Rubber water hose (¼-in. wall thickness) and steel channel is used to protect and support the cable runs. It has the reliability and flexibility required, it does not corrode or vibrate loose, and when the ends are sealed water and dirt is excluded. As an example of this method an AISE 608 mill motor, 230-volt d-c 175-amp, 45-hp, would be

TABLE I

Crane Wiring Data for Use with MD-600 Series Motors for Rubber Covered Wire 60 C Rise (AWG Sizes Used)

Motor frame size	30-minute hp	30-minute amps	Motor wiring size	Hose size, in. diam	Volts drop in 100 ft	Resistor wire size
402	6½	29	8	4 No. 8—1	7.5	8
602	10	44	8	4 No. 8—1	11.4	8
603	13½	57	6	½	10	8
604	19	77	4	½	7.2	6
606	33	126	1/0	¾	5.1	2
608	45	175	2/0	¾	5.7	1
610	65	245	4/0	1	5.0	2/0
612	100	368	350	1¼	4.5	4/0
614	135	500	500	1¼	4.28	350
616	200	740	2-350	Two 1¼	4.5	500
618	265	960	2-500	Two 1¼	4.1	500

Based on 100 ft between motor and control

Hose size	Control wire no.				
	14	12	10	8	6
Volts	600	600	600	600	600
½-in. diam	2	2	1	1	1
¾-in. diam	5	5	4	2	1
1-in. diam	10	10	7	5	4
1¼-in. diam	15	15	10	8	6

Channel size, in.	Number of hoses in channel*		
	¾ in.	1 in.	1¼ in.
4	2 (2)	2 (2)	2 (1)
5	4 (2)	...	...
6	5 (2)	4 (2)	...
7	6	...	...
8	7 (3)	5 (3)	4 (2)

* No. hoses per channel are for one layer; no. in parentheses indicate no. of layers which may be used.

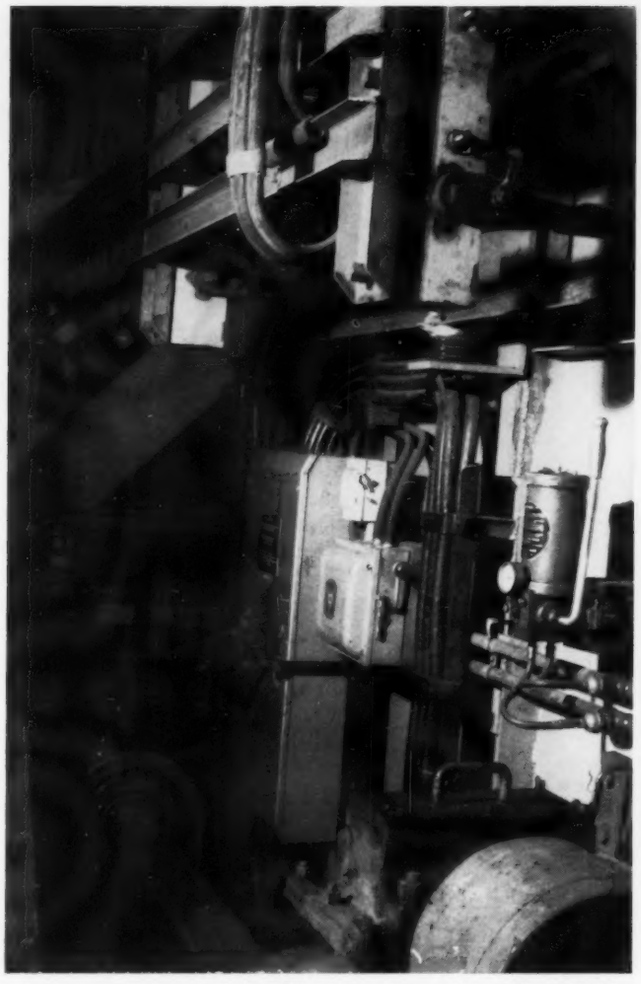


Figure 6 — These six 500,000 circular mill cables feed a 1200-amp main isolation switch on a man trolley soaking pit crane.

Figure 7 — Hoist motor wiring from back of panel to trolley collector angles.

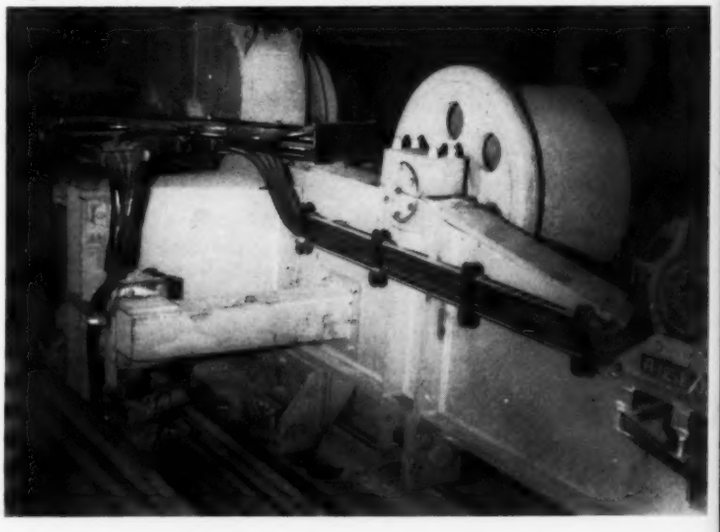
fed by four size AWG No. 4/0 wires each of which would be pulled through a ¾-in. diam hose and then nested into a 4-in. channel. This method is used on all motors up to 265 hp, with various combinations of wire, hose and channel size being used. Resistors are connected in a similar manner except that the wire adjacent to the resistor is wrapped with asbestos tape, the rubber hose being used when the wire is beyond the heat zone. The wiring standard shows the various combinations for motors, resistors, and control wiring. Figures 6, 7 and 8 show electrical equipment installed by Stelco.

Control—Each motor panel would have overload and undervoltage protection, control and main line knife switches, ammeter shunts for test purposes. Control wire would be stranded type A18 minimum size No. 12, and each contactor would be mounted on an individual slate. Terminal blocks can be a source of trouble, and special attention should be given to the type used. When wired, spraying them with a water proofing agent similar to those used in the automobile industry can increase their reliability.

Bridge or trolley drive and control—Recent tests have shown that 3-point master switches are all that are required. On 5 and 6-point control intermediate notches are used very infrequently and for very short periods of time. Therefore why not combine them into one intermediate notch. The control used has three stages of acceleration and two of plugging, the crane moving on first point of control.

Our methods of selecting motor size, gear ratio and resistor layout differ from AISE Standard No. 6. We define performance as the initial rate of acceleration on the resistor and the speed after ten seconds from rest. The duty cycle is classified as standard, medium or heavy and determined by the per cent time on a hypothetical cycle of repeated acceleration to base

Figure 8 — Wiring to collector post of 50/30-ton trolley.



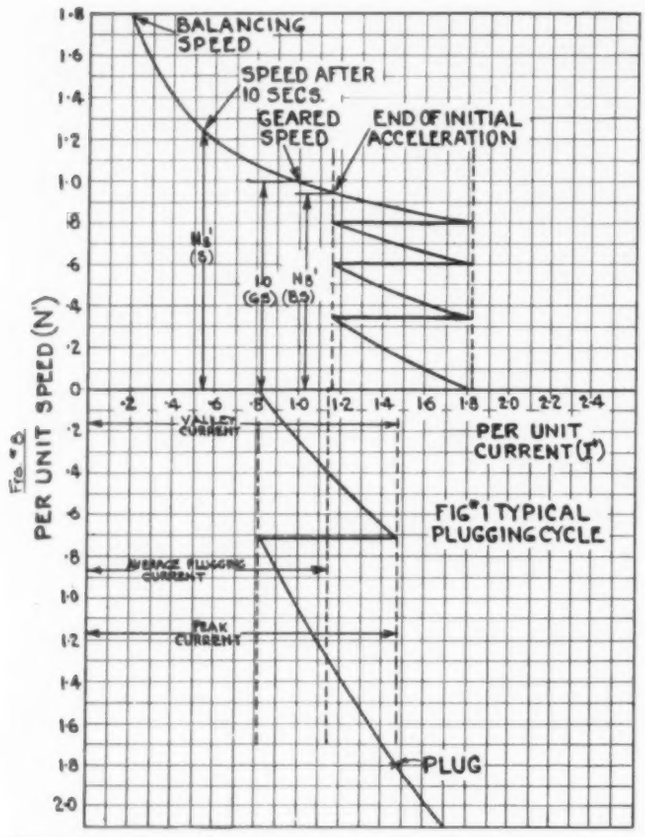


Figure 9 — Operating characteristics for a Frame 600 series, 60-minute rated motor.

speed and plugging to a stop, the per cent time being *7½, 10 and 15*. According to the duty cycle the average acceleration current would be limited to *172, 148 and 124* per cent of the 60-minute current rating of the motor. The three stages of acceleration and two of plugging would have equal peaks and valleys of current. This method is fully explained in "Control and Drive Equipment on D-C Electric Traveling Crane Bridges," by D. C. McCrady, 1954 AISE Proceedings. Figure 9 shows bridge motor operating characteristics.

Hoist drives—We use AISE Standard No. 6 for motor selection. One requirement is, if only one hoist brake is used, it be mounted on the high-speed pinion shaft of the hoist drive rather than on the motor armature shaft. The latter could break and separate the hoist brake from the load.

Hoist limit switches—Hoist limit switch failure is one of the main causes of crane accidents. We recently damaged a pair of auxiliary trolley girders on a 350-ton ladle crane. The girders were 75-ton capacity and were buckled by the ladle lifting beam when the main hoist power limit switch failed to operate. To prevent this happening again we are installing control type limits; these are the rotating type driven by the hoist drum shaft, and will be used in addition to the power limit switches already installed on all ladle cranes.

The simpler a limit switch arrangement the more reliable it becomes. Mounting the switch so that the limit weight hangs straight down from the switch lever striking the hook block on its vertical center line is best. Hoist cable guides to prevent the weight swinging out of line and a safety chain anchored to the trolley, should be attached to the limit weight.

When buying or making electrical equipment for a group of cranes, the following can be made standard and has been done at Stelco: collector systems, hoist limit switch arrangements, brake wheels, motor couplings, master switch layouts, lighting and warning fixtures, magnet control and power supply systems. With reference to lighting on d-c cranes we now use mercury vapor fixtures, and these have proved highly satisfactory.

BRIDGE DRIVES

It is not the intention to discuss taper thread wheels versus straight tread. However, in most of our new installations we have used the 171-lb rail, which has a flat crown, and bridge wheels allowing 1½ in. float. Little trouble has been experienced with this arrangement, and we will probably continue to use it. Figure 10 shows a standard wheel assembly and swing-up bumper.

One of the biggest hindrances to good bridge tracking is the bridge line shaft, because any slight difference in bridge wheel diameters will make the crane skew. A number of our ladle and small semi-gantry cranes have individual worm drives, and no tracking problems have been experienced. Recently on the A-6 type drive (a motor and gear box at each end with connecting line shaft) we have disconnected the line shaft. The cranes upon which we have done this are 115-ft span and 50-ton capacity. The two drive motors are connected in parallel, and a standard duplex control is used. This has resulted in better performance, the 600 series motors have sufficient stability to load share and the elasticity of the drive allows the crane to float rather

Figure 10 — Bridge wheel and swing-up bumper of a 50/30-ton crane is a standard assembly.

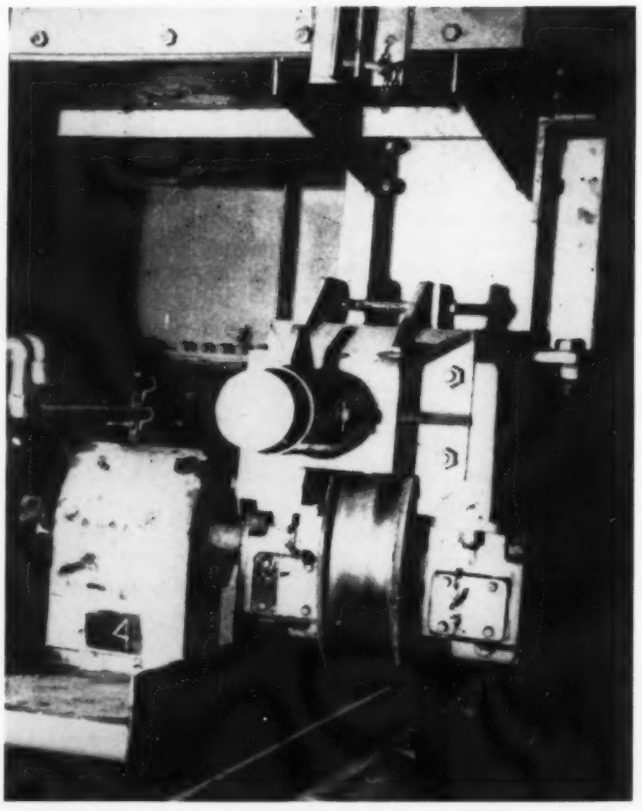


Figure 11 — After disconnecting torque shaft of AISE A-6 bridge drive better operation was obtained.

than skew. If we can eliminate line shafts and build the drives into the end trucks, we could eliminate the use of auxiliary girders. These are often a source of trouble due mainly to lack of lateral stiffness. Figure 11 shows the line shaft disconnected on an AISE Standard No. 6 bridge drive.

The bridge wheel axle bearings used are an enclosed sleeve type mounted in a Master Car Builders type removable box, fitted with oil retaining seals. The bearing surface is babbitted with the babbitt being approximately 87 per cent tin, 8 per cent antimony and 5 per cent copper. This type of bearing is used on quite a number of cranes and has given good service. It is grease filled and is connected to the centralized lubrication system of the crane, the grease used being a soda base type. In addition, there is a second grease fitting connected to the bearing, and it is used to pump the bearing full if the crane has been standing idle or during a maintenance check. A 5-psi relief fitting is also installed and this acts as an indicator that the bearing is full and also prevents damage to the oil seal.

Lubrication—Lubrication developments have improved the performance of our cranes. Briefly here are a few of the things which have been done:

The life of hoist cables has been increased by the use of heavy leaded grease impregnated fiber cores. The grease is heated to 250 F and applied during the stranding and closing operation when the cable is made. When the cable is in service, the same grease is used; but it is cut back with a solvent and used as a penetrating oil to penetrate the cable and saturate the hemp core.

The use of nylon tube rather than copper tube in exposed locations has made the centralized lubrication systems more flexible.

Oil pumps have been installed to lubricate drives rather than rely on splash lubrication. This is sometimes a problem on trolley drives where a vertical gear train and bearings have to be lubricated. Another way of getting around this is to use grease rather than oil-lubricated bearings.

On cranes where the hoist is operating in a guide frame, a "stiff leg" crane, the guide frame slides are lubricated by the use of a multi-unit pump, separate pump motor and starter. The starter pushbutton is replaced by auxiliary contacts on the "M" contactor of the hoist motor control so that the pump runs only when the hoist is being used.

GEARING

Our preference is straight spur teeth for normal requirements. However, a number of worm and worm wheel drives for hoists and bridge travel drives are used. As a basis for design we use the Lewis formula and the American Gear Manufacturers Association Standards No. 220.01 and 210.01, sections of which are included in the AISE Crane Specification No. 6. Briefly this standard is a modification of the Lewis formula and Hertz equations, using these to check the allowable durability horsepower and peak strength horsepower. Most of the gears used have a hardness of approximately 600 Brinell, but for the purpose of design we consider it to have a Brinell of 300. Checking the horsepower rating based on durability, a gear having 600 Brinell has a rating almost twice that of a gear of 300 Brinell. If however, the two gears are checked for peak strength then this difference in rating would be reduced.

Our reasons for doing so are:

a. We have increased gear life.
b. We can increase the rating of the drive at some later date if necessary.
c. Gears having a Brinell of approximately 300 can be made at Stelco and used in an emergency.
d. The writer does not fully understand AGMA No. 220.01 and 210.01.

Material used at Stelco would normally be:

Pinion SAE 1040, 245 Brinell, allowable stress 20,000 psi.
Gear SAE 1040, 210 Brinell, allowable stress 15,000 psi.
Pinion SAE 4140, 285 Brinell, allowable stress 30,000 psi.
Gear SAE 4140, 250 Brinell, allowable stress 25,000 psi.

The allowable stress is that used to calculate strength horsepower rating, and is approximately one-fourth of the yield point of the material.

HOIST CABLES

The type of cable used on cranes is usually 6–19 or 6–37. The 6 is the number of strands and the 19 or 37

is the number of wires which make up each strand which in turn are twisted around either a hemp or steel core. Flexibility is governed by the size of wire, for a given diameter of cable the wire diameter of 6–37 is approximately 70 per cent of that used in 6–19. This makes the 6–37 a more flexible cable, but it has less resistance to abrasion than the 6–19 type cable.

There are two main causes of cable failure, fatigue and wear. The latter can be measured or evaluated by routine inspections, this being done either daily or weekly depending on the duties of the crane. Fatigue is more insidious since it cannot be determined by visual inspection, but it can however be calculated approximately.

The practice of substituting 6–19 cable for 6–37 can sometimes result in a crane accident. Normally this change is made when the 6–37 cable is being replaced frequently because of wear. The 6–19 has a higher resistance to wear but may fail suddenly because of its lower resistance to fatigue. No changes of the type of cable used on a crane should be made until a study has been made of the hoisting arrangement to determine whether fatigue would be a problem.

Fatigue failure under combined stress conditions is not a clearly defined subject. The stresses present in a cable consist of tensile stress due to the load and sheave friction, bending stresses due to cable movement over hook sheaves and compressive stresses which have a pinching effect. The latter tends to pinch the wires, make them act together as a solid mass and thus greatly increase the bending stresses.

A great deal of experimental work has been done on this subject. Our methods of calculating fatigue life are based on work which was done by D. C. Drucker and H. Tachau, ASME Trans. Vol. 66, 1945. These tests indicated that a dimensionless bearing pressure variable "B" is of main importance when selecting cable type and size.

$$B = \frac{2 \times (T) \text{ cable load}}{(U) \text{ ultimate strength} \times d \text{ (cable diam)} \times D \text{ (sheave diam)}}$$

A graph showing the relationship of cable life to this bearing pressure is shown. Cable life is expressed as the number of bends to failure. One bend is a flexing of the cable through 180 degrees and back. Figure 12 shows the fatigue life graph.

In the steel industry crane cables are usually worn out long before they reach their fatigue limit. There are, however, cranes operating in clean locations, for example a shipping crane, which may have under-size sheaves or a reverse bend in the reeving arrangement, giving the cables a life of six months or more. This type of crane is often a source of danger due to cable fatigue.We have had this type of failure, the cable showed no signs of wear. At the point of fracture there was no elongation or reduction in section of the wires.

There are a number of ways in which cable life may be increased: proper lubrication, correct sheave groove size and diameter (this is important if the compressive stresses are to be kept as small as possible), the use of slack cable limit switches on magnet cranes preventing slack cable when the magnet has been lowered to the ground and the resultant snap action when lifting. The design of reeving arrangements should be such as

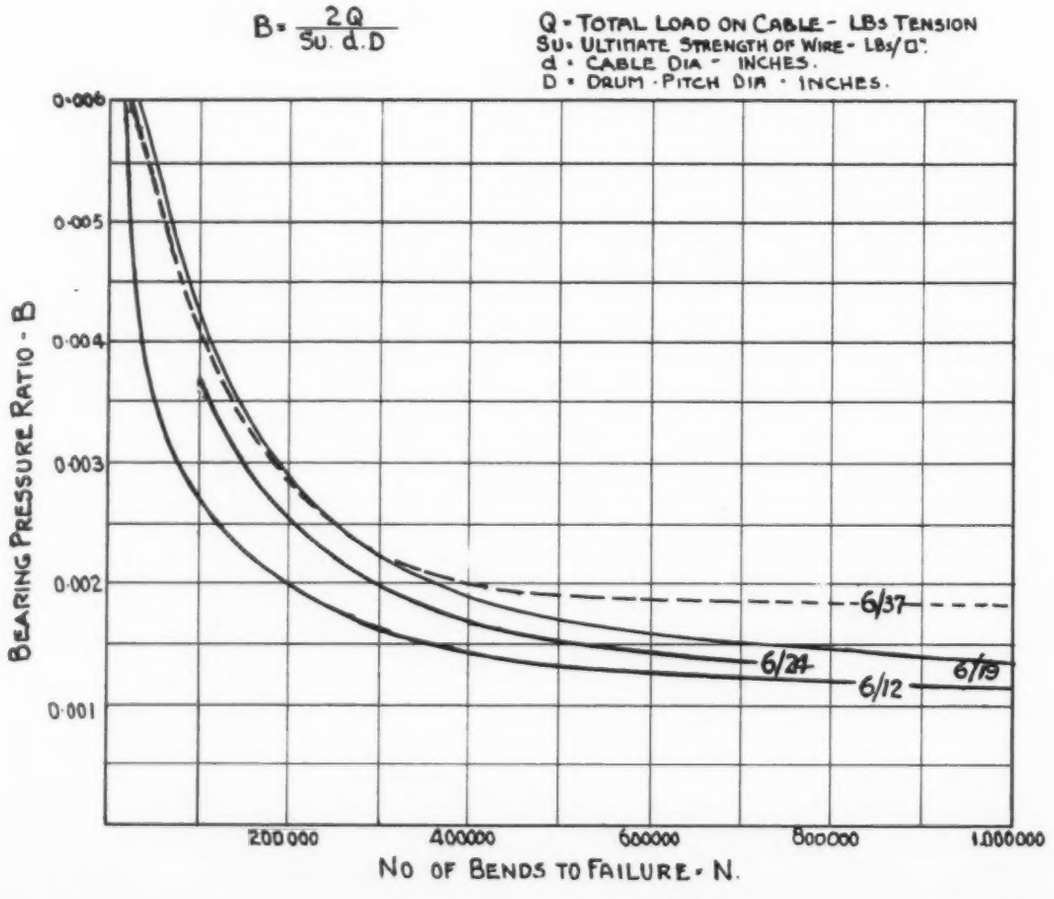


Figure 12 — Fatigue life of hoist cables can be determined from these curves.

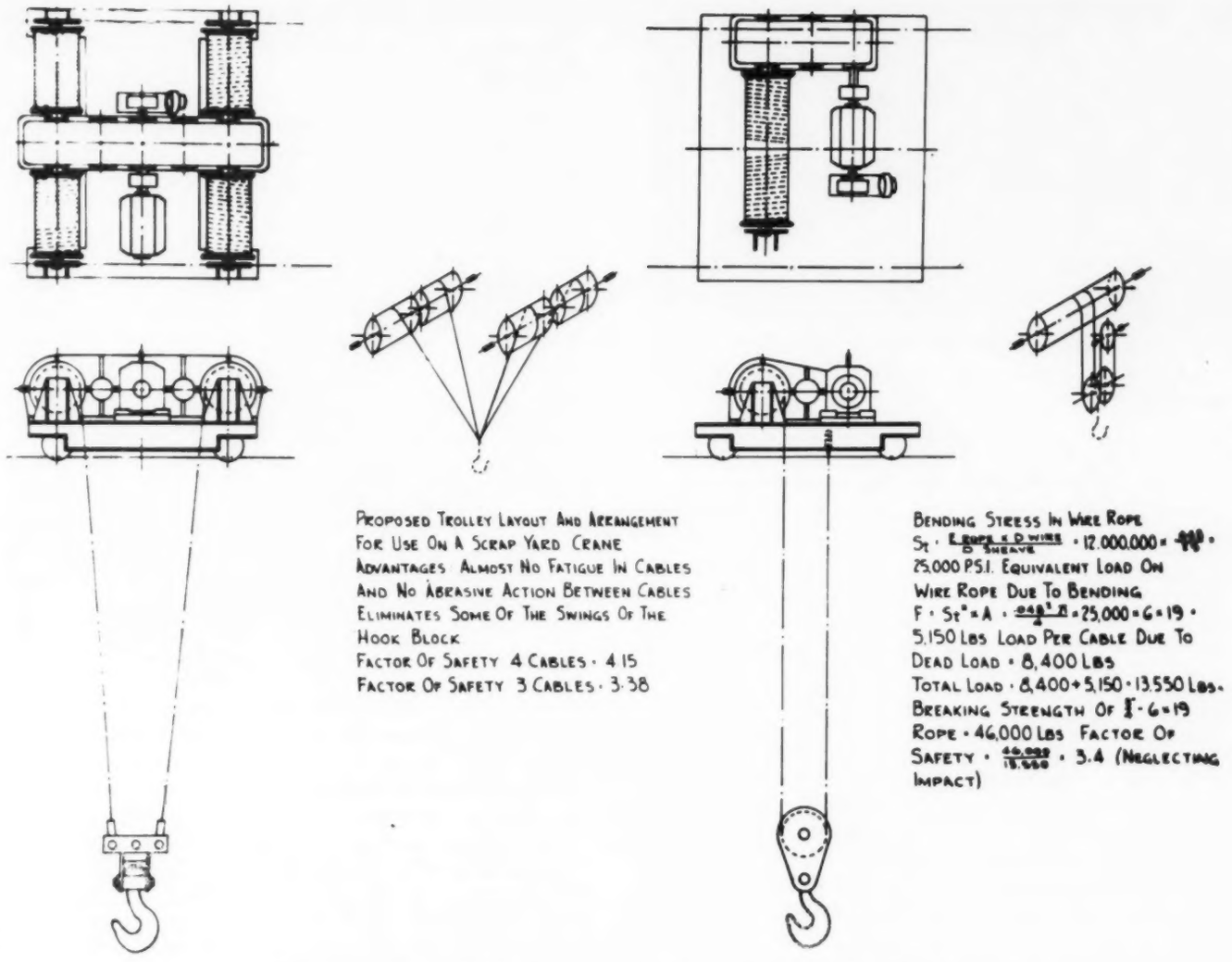

Proposed Trolley Layout And Arrangement
For Use On A Scrap Yard Crane
Advantages Almost No Fatigue In Cables
And No Abrasive Action Between Cables
Eliminates Some Of The Swings Of The
Hook Block
Factor Of Safety 4 Cables · 4.15
Factor Of Safety 3 Cables · 3.38
Bending Stress In Wire Rope
$S_t = \frac{E_{rope} \times D_{wire}}{D_{sheave}} = 12{,}000{,}000 \times \frac{.048}{18} = 25{,}000$ PSI. Equivalent Load On
Wire Rope Due To Bending
$F = S_t \times A = \frac{.048^2 \times .7854}{2} = 25{,}000 \times .6 \times 19 =$
5,150 Lbs Load Per Cable Due To
Dead Load = 8,400 Lbs
Total Load = 8,400 + 5,150 = 13,550 Lbs.
Breaking Strength Of $\frac{3}{4}$" 6 × 19
Rope = 46,000 Lbs Factor Of
Safety = $\frac{46{,}000}{13{,}550}$ = 3.4 (Neglecting
Impact)

Figure 13 — This reeving arrangement is meant to increase cable life.

to give the cable an infinite fatigue life and keep cable wear to a minimum. Figure 13 shows cable reeving arrangements.

STRUCTURAL DESIGN

At the present time the majority of cranes being built are of welded construction. Welding has certain advantages over riveting, in that it costs less, it has a higher strength-weight ratio, and because of its smoother design, it prevents the formation of water and dirt pockets. It can, however, have a large number of disadvantages unless strict control is given to design details, choice of material, and workmanship. We have had failures occur in crane girders and have had to scrap others before failure occurred because of defective welding and design. Welds and rivets do not usually mix, an example of this being the reinforcing of a riveted girder by welding additional plates to the bottom and top chord. It can result in fatigue failure because of the notching effect of the weld and the chemistry of the steel with the end result being that the girders have been weakened rather than strengthened. Figure 14 shows a fracture in the bottom flange plate of girder.

For the basis of design, AISE Standard No. 6 is generally accepted. However, there is a tendency to design to a lower unit tensile stress than 18,000 psi or a compressive stress of 17,000 psi. A number of factors would influence the unit stress used: the location, the effects of corrosion, the tendency to overload or increase the capacity, the possibility of damage to the underside of girders, maximum permissible wheel load. Normally we would use 14,000 psi unit stress.

The correct choice of material is very important, AISE Standard No. 6 mentions two steels ASTM A-7-46 structural steel and low alloy structural steel neither of which are really suitable for crane girders. The latter would not be used because of rigidity, a crane must have the least amount of vibration possible if fatigue is to be avoided. The use of low alloy steels and the higher unit stress would tend to give greater deflections and increased vibration. It can, however, be used in the manufacture of large ladle cranes where this would not be too much of a problem. The ASTM A-7-46 structural steel is sometimes suitable depending upon who or how the steel was made. Briefly this steel specification is a physical control and has no chemistry control. This latter control is essential, as carbon content, grain size and notch ductility must be controlled if the steel is to be used to build crane girders.

There are two other ASTM specifications to choose from, A131-53T used mainly for ship building and A373-54T a structural steel for welding. The latter

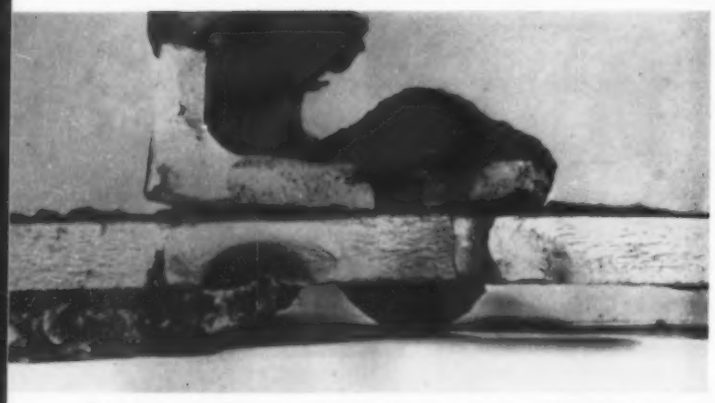


Figure 14 — Fracture in bottom flange plate of girder of soaking pit crane.

does not have quite as good chemistry nor control of grain size for thicknesses of material over 1 in., as does A131. However, it is more readily available and can be furnished as a fully killed steel for all thicknesses over 1 in. These two steels should be used in preference to ASTM A-7-46 structural steel if the chance of brittle fracture occurring is to be minimized. It is hoped that any future revisions made to the AISE specification will include more explicit information on welded girders. The American Welding Society has done a great deal of research work on this subject, and we can benefit from it.

We use a minimum plate thickness of $\frac{3}{8}$ in. on girders. When proportioning a welded girder we ask that the flange plates be at least 6 in. wider than the distance between the web plates, it is normally about 2 in. wider. This gives better edge condition and protection for the fillet weld. The 3-in. wide lip also provides a place into which 4-in. diam pipe may be nested to protect the inside edges of the bottom flange plate and decrease wear on hoist cables.

The design should be such that the welds do not impose severe local constraint and concentrations of stress at the critical points. We try to avoid butt welding flange plates but, if necessary, we prefer that the tension member be welded before assembly. The edge condition at the ends of the butt weld must be as good as possible, with run-out plates being used and upon completion the edges ground square and the weld magnafluxed. In most cases where trouble has occurred, it has been because of defective welds or welds of the wrong size and shape. Often not enough attention has been paid to edge preparation or location to make possible good welds.

Workmanship is highly important when building welded structures. The type of welding rod, proper welding sequences, the size and shape of welds, and edge preparation, all must be given careful consideration and control. We would normally specify the type of steel to be used as A373, with the type of welding rod as E7016 or 6016 (low hydrogen). We would also inform the builder that prior to erecting the crane we would sand blast and magnaflux approximately five per cent of the welds.

SAFETY

Our safety rules are very similar to those used in most steel industries. There have been a number of papers given on this subject with one of the best being "Protection of Men Exposed to the Hazards of Moving Overhead Electric Cranes," by H. R. Miller, 1956, AISE Proceedings.

The safety rules are such that a crane cannot be repaired if there is not the required number of safety men available. When cranes are working on adjacent runways and there is a fault in a crane bridge end truck, the repair cannot be done until safety men have been positioned in the cabs of adjacent cranes and on the cranes working in the next aisle. In our No. 2 open hearth this means seven crane safety men in addition to the man stationed below. In an effort to reduce this number to two, and we believe increase the standard of safety, we propose to install the following system. Figure 15 shows No. 2 open hearth crane layout.

1. In each of the seven cranes, No. 21, 22, 23, 24, 25, 27, and 28, is installed a carrier current phone system using the d-c collector rails as a carrier medium. The individual sets consists of a "press to speak" microphone and a small loud speaker. These speakers have volume control but the operator cannot switch them off completely.

2. Two phone stations would be installed, one in the pit foreman's office and one in the melters office. These would increase the open hearth's efficiency.

3. Each crane has a certain section of runway in which it is parked when repairs, or overhaul work is being done. Below each of these sections at ground level an outlet is provided to which a portable phone set may be connected.

4. At the end of each parking section red gyro warning lights are to be installed. These lights would be operated by the person responsible for the repair work, and are similar to those used on locomotives.

Briefly the whole system would work this way:

1. The man responsible for the repair work can, by using the ground station phone, inform all crane operators simultaneously of what he is planning to do. He then asks each operator in turn to confirm that they have heard and understood him.

2. The crane is then moved to a parking section, and the warning lights at each end of that section switched on.

3. The safety man stationed below the crane watches floor traffic and crane movements. In the event of a crane approaching the working area, this man can warn or caution the operator by using the portable phone which he carries with him.

Crane inspections are one way of insuring safety.

Figure 15 — No. 2 open hearth crane layout.

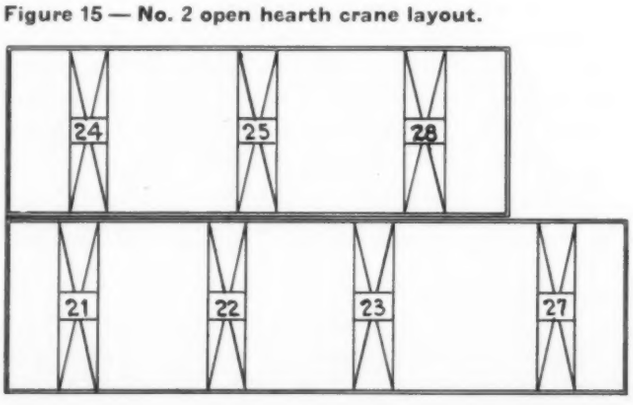


Figure 16 — This mechanical strain gage can be used to check crane stresses.

They are inspected by three groups, electrical, mechanical and engineering. The engineering inspection is yearly and in no way reflects upon the other inspections. When the engineer makes the yearly crane inspection, he checks the structure at its critical stress points looking for cracks, checks the steel thickness and appearance. It is often difficult to say just when a crane should be scrapped. A yard crane may from an external inspection appear to be in good condition but by drilling and measuring the thickness of the bottom chord member you find $\frac{1}{8}$ in. of good material and $1\frac{1}{2}$ in. of rust scale. As a result the crane is scrapped. Another crane may fail because of fatigue, with a crack that may have been progressing for some time before complete failure occurs. The only way to discover these things is to sand blast the connection and ask the metallurgical department to magnaflux the area. It is a good plan that after cleaning and prior to painting a crane, that the girders be given a complete inspection. Recently, we purchased a mechanical strain gage, having an accuracy of 0.001 mm which can be carried in one's pocket. A good feature of this instrument is that it does not require that two holes be drilled to set the gage distance. Instead two $\frac{1}{16}$ in. stainless steel balls are placed in center punch holes and then, by means of a snap head punch, swagged permanently into the steel. We have used it to check stress calculations and to test old cranes. It needs no setting up, but is just held across the gage length and a direct reading taken. Figure 16 shows the gage.

SUMMARY

In conclusion, we would like to state that AISE Crane Specification No. 6 is good, but technical progress requires that certain revisions be made from time to time if they are to retain their value. The revisions could be based on the following: (1) structural investigations on all welded cranes while they are in use in a mill using electrical strain gages to measure dynamic and static stresses, evaluating the effects of impact and lateral loads, (we have the equipment and facilities and would welcome the tests), (2) cable investigations and life tests made on cranes, (3) steel specifications controlling grain size, notch ductility, etc., (4) standard sheaves, wheels, hooks, (5) motor selection methods and (6) most important the methods by which a crane performance is defined.

To make such revisions would involve a great deal of work but would prove very worthwhile to both the crane builder and the steel industry.

"METALLURGICAL CONTROL IN CONSTRUCTION AND MAINTENANCE"

by John Bird

Laboratory Metallurgist

The Steel Co. of Canada, Ltd.

Hamilton, Ontario, Canada

GENERAL PROGRAM

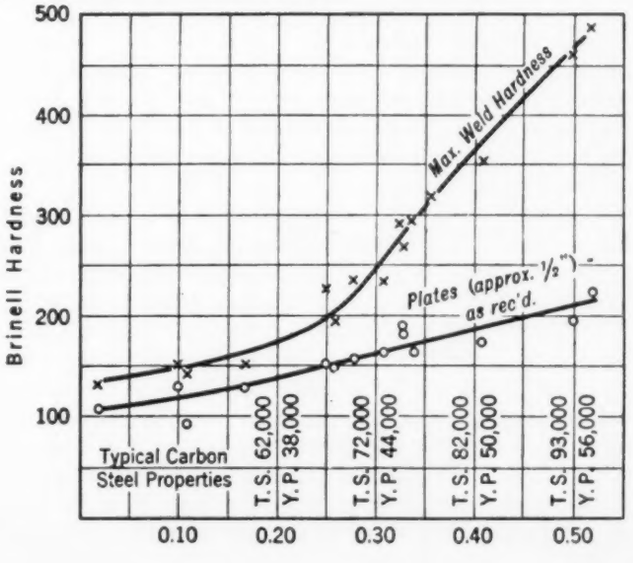
Our metallurgical control of overhead cranes, other lifting equipment and accessory items can be divided into three general classifications:

1. Construction of new equipment.
2. Selection of materials.
3. Maintenance program.

CONSTRUCTION OF NEW EQUIPMENT

In this category our work together with the engineering department is pretty well confined to those items or accessories which are peculiar to our plant and industry rather than the basic structure or the bridge itself.

Figure 17 — Effect of carbon content in plain carbon steels on weld hardening. Lower curve shows plate hardness, as received. Typical tensile strength (T.S.) and yield point (Y.P.) values for normalized plates are also given.



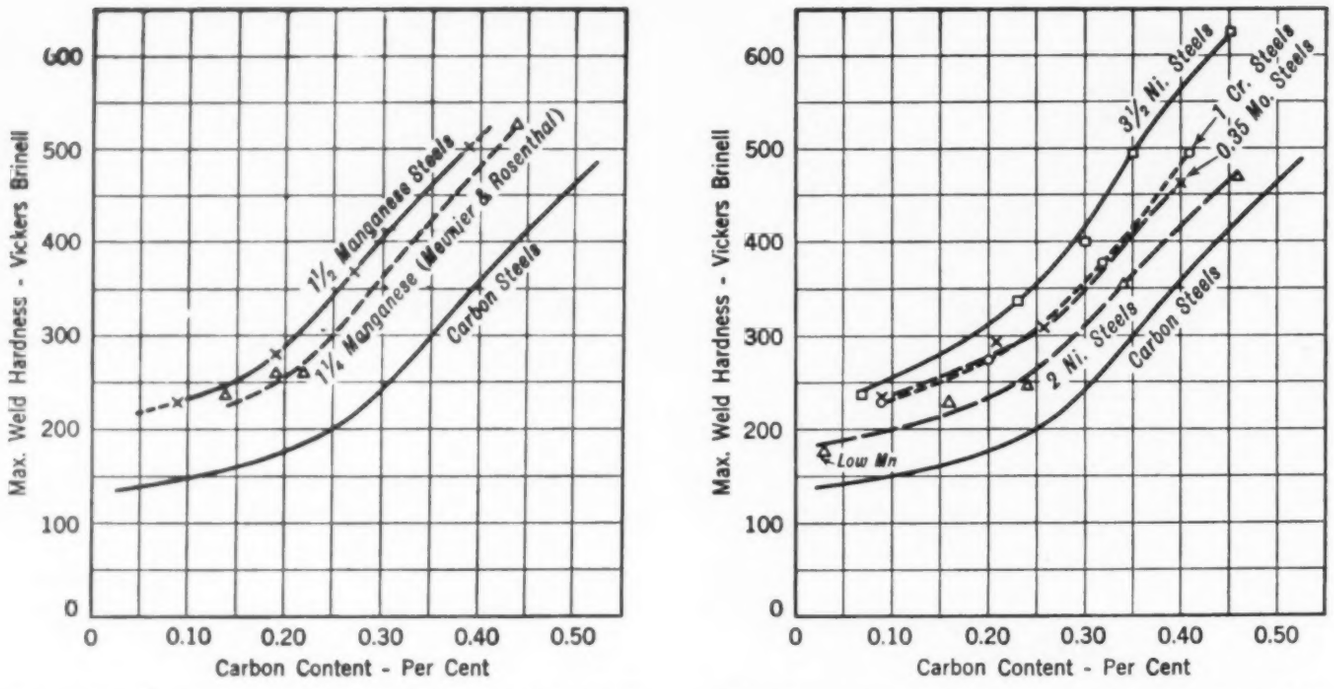


Figure 18 — Maximum weld hardness in ½-in. plates of carbon steels and ternary steels of manganese, chromium, molybdenum and nickel. Surface beads are deposited at about 5 in. per minute. Heavily coated 3/16-in. electrodes were used.

The following procedure has been adopted by the engineering department on the drawing of lifting equipment:

1. The specifications of the material to be used and the required heat treatment shall be clearly stated for each item.
2. The following note shall be added to all lifting equipment drawings—"No welding will be permitted on any item except as shown."
3. Where welding is necessary, type of welding rod and procedure to be used are to be clearly defined.
4. When a drawing is complete, a print of the drawing will be submitted to the metallurgical department for their comments or approval. Drawing will be appropriately stamped by the metallurgical department and returned.
5. Above procedures will apply to revisions.

SELECTION OF MATERIALS

This category includes the specifying of component parts of equipment outlined in new construction, recommendations on assemblies made up by other companies, and the standardizing of the grade of steel for the forging and fabrication of accessory items.

We have attempted, with a good degree of success, to standardize C 1020 fully-killed, fine grained steel for forged and fabricated items such as hooks and bales. This grade is considered to have the best combination of impact strength, tensile strength, ductility, forgeability and weldability. It is made silicon killed, aluminum added for grain refinement. The common blacksmith iron or open hearth iron as it is frequently called, that is dead soft rimmed steel, is used in the forge shop initially for chains and is forged into many other items. We do not present metallurgical opposition to the use of this steel for simple forgings such as hooks because it is the most forgeable material available and plain hooks are overdesigned to such a degree that strength is not a factor. However, the greatest danger of misapplication in the forge shop is the use of higher carbon steel such as 0.40/0.50 which is traditionally applied because of its higher tensile strength.

Another purpose for using 0.20 per cent carbon steel is that it has less susceptibility to grain growth than lower carbon steel in normalizing, which is periodically carried out to our specifications. Also being of relatively low hardenability there is less danger of weld hardening, either with required specified welding or with unspecified welding in the field. It seems to be a common practice in all plants for maintenance men to indiscriminately weld handles and other such conveniences on lifting accessories and make field repairs by welding and for this reason a steel of low hardenability is advisable.

MAINTENANCE

A continual maintenance program is carried out on accessory items on all shop and mill cranes. Initially, all new forged and fabricated parts are inspected, being spark tested to ensure that the correct analysis has been used and then the part is magnaflux tested for crack detection. Before being put into service, all forged parts are normalized to create the most desirable metallurgical properties. Welded fabrications are stress relieved in lieu of normalizing. In service, inspection is generally carried out annually on the same items on each mill. All hooks, bales, chains, etc., are again spark tested, magnafluxed, stamped and catalogued. Periodic normalizing is specified on parts subject to abrasion and depending on the frequency and severity of the particular operation is carried out every six months, annually or biannually. This, of course, is to remove cold work which can lead to early fatigue cracking and a full normalize at 1650 F, one hour per

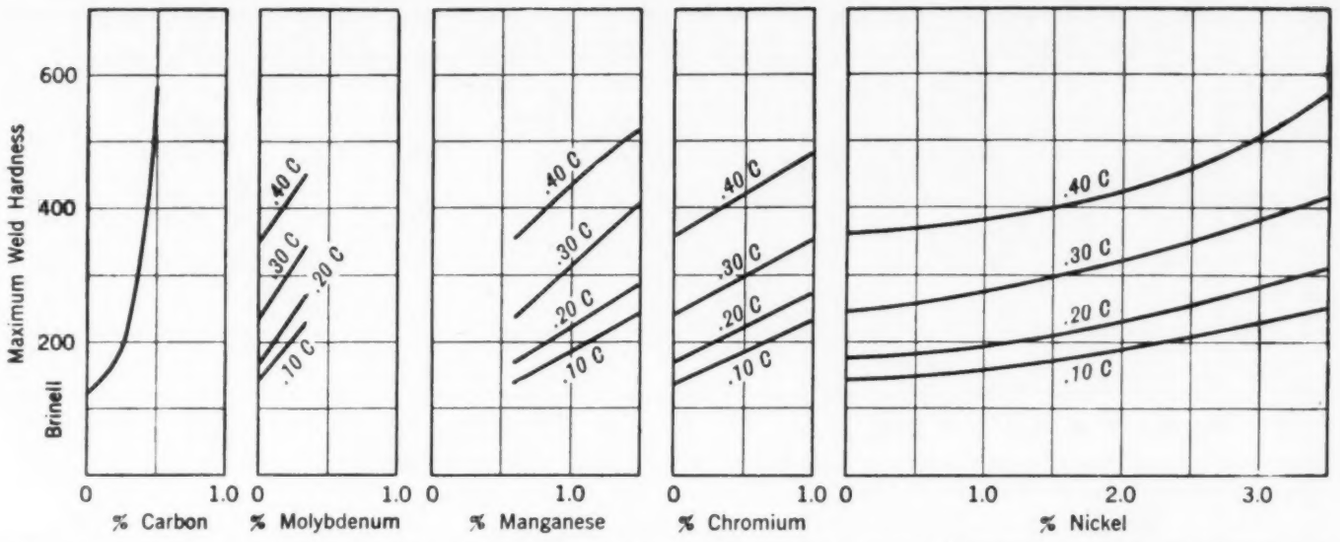


Figure 19 — Effects of carbon, manganese, chromium, molybdenum and nickel on weld hardenability of steels containing different carbon contents.

inch is required; sub-critical stress relieving is avoided because of the danger of grain growth from cold-worked metal.

An equally important phase of the maintenance program is the metallographic investigation of all failures to determine the cause of breakages.

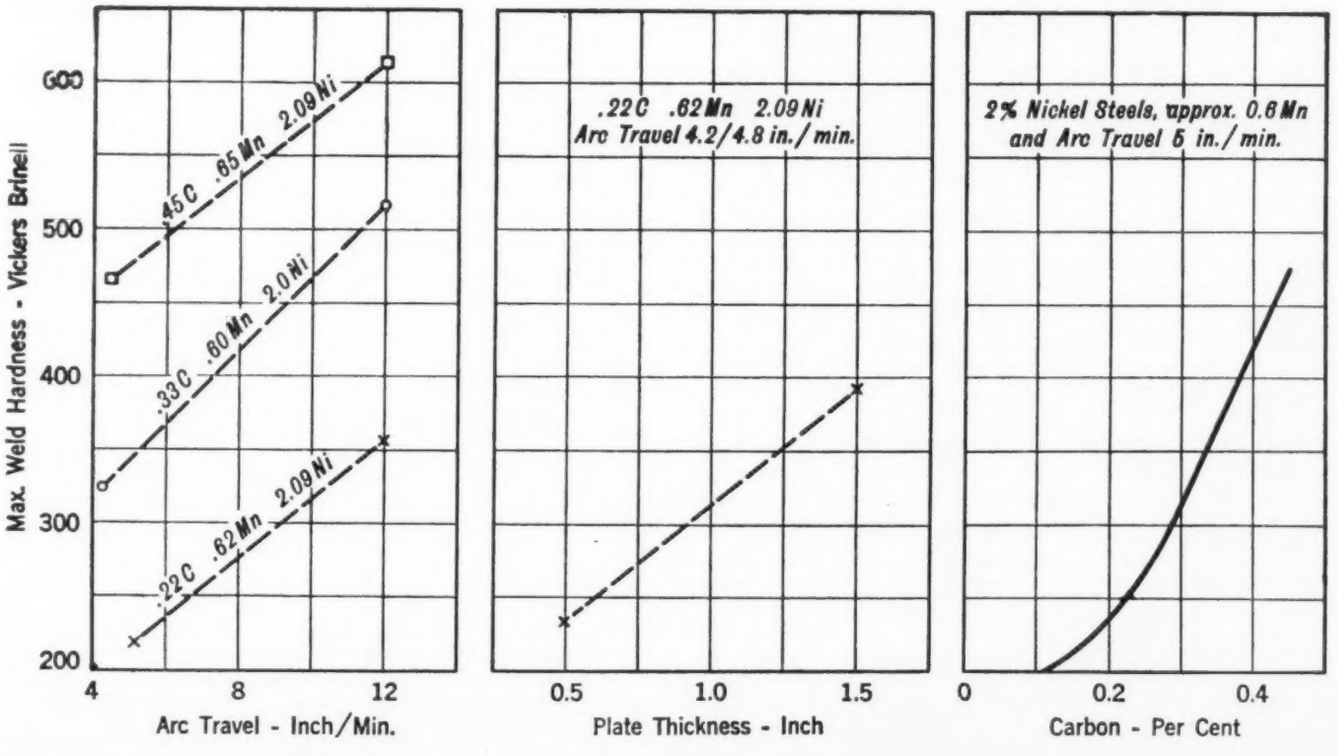
IMPACT STRENGTH

In discussing the selection of material for overhead items, it was stated that impact strength is an important steel property. This property is more critical than it is generally considered to be, particularly in the component parts and accessory items of cranes which operate at low temperatures.

Impact strength is the ability of material to resist brittle crack initiation and propagation under shock or impact loading. This property is generally referred to as a material's notch toughness or notch ductility. Many factors affect this property in steel such as analysis, condition, steelmaking practice, grain size, temperature which we will go into in more detail shortly.

In the laboratory, impact strength is determined by the fracturing of a notched test specimen. This test is of definite specified dimensions, approximately 0.400 in. sq x 2 in. in length with a V or U-notch, the notch depth ranging from 20 to 30 per cent of the section depending upon which is selected. The two testing methods, performed on the same machine are the simple beam and the cantilever beam tests known

Figure 20 — Maximum weld hardness of 2 per cent nickel steels as affected by arc travel speed, plate thickness and carbon contents.



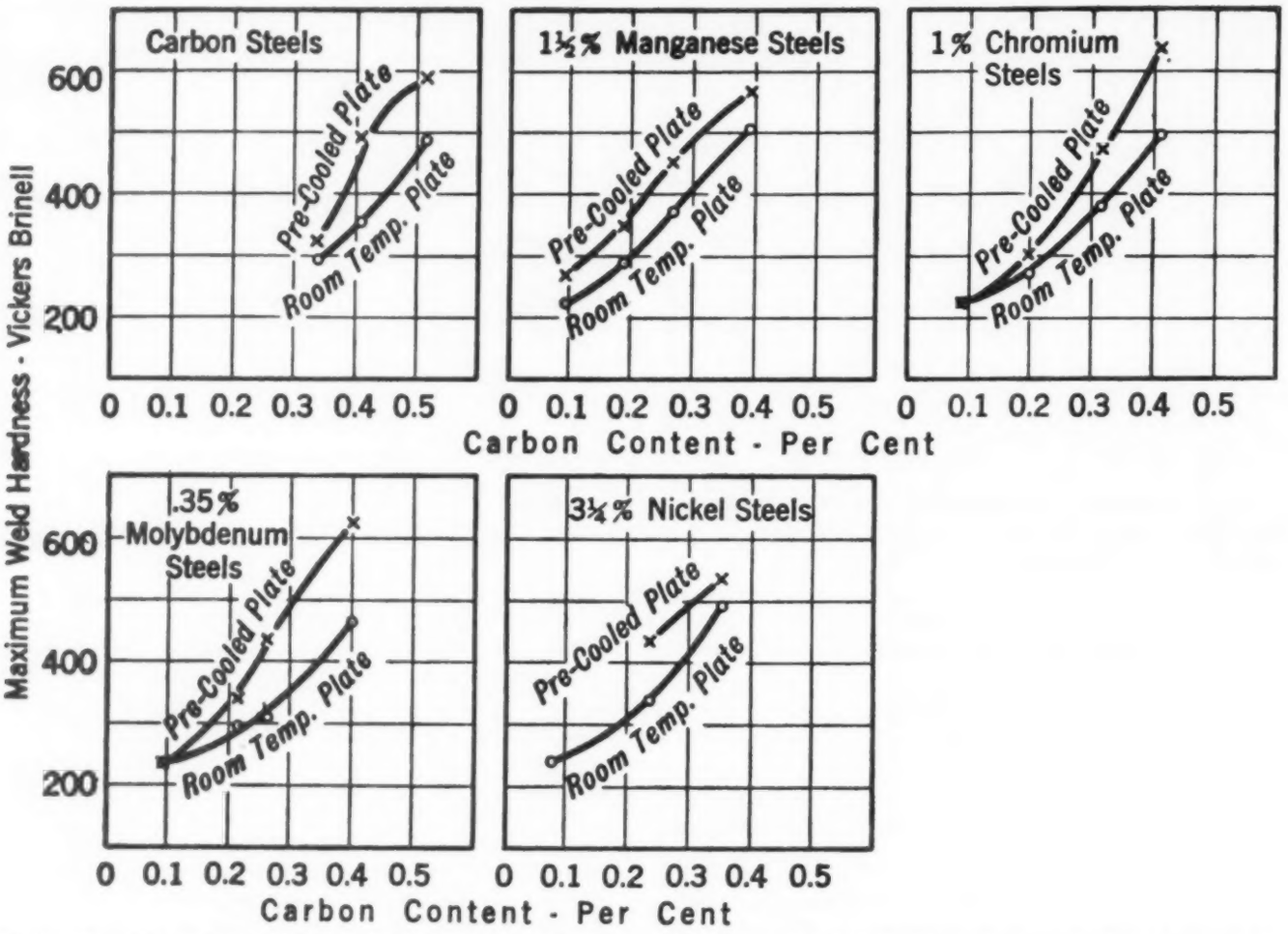


Figure 21 — Effect of precooling to 5 to 10 F on the maximum weld hardness of carbon steels and ternary steels of manganese, chromium, molybdenum and nickel. Tests on ½ in. plates welded at about 5 in. per minute arc travel.

as the Charpy and Izod, respectively, and give similar values. Test result is established by placing the test across an anvil, and a weighted pendulum is released to strike the notched specimen at the point of greatest velocity. The energy absorbed in fracturing the test controls, of course, the degree to which the pendulum completes its swing, and an automatic recording is made in ft-lb. Impact values are expressed in ft-lb.

Steels which behave in a ductile manner in the conventional tensile test will frequently behave in a brittle fashion under impact conditions. Therefore, the value of impact strength is not ductility alone but the relative notch brittleness of various steel grades. The word "notch" is used frequently because under service conditions, brittle failure is usually associated with an undercut, sharp change in section or some other such area of stress concentration.

The most influential factor on impact strength is temperature, the lower the temperature the lower the values. As anyone knows metal is less ductile at low temperatures. Because service conditions of structural members demand good impact strength at low temperatures and because of the variation in values over wide temperature ranges, tests are generally conducted from room temperature down to −100 F for comparison of values at any given point. It has been found, particularly with low carbon plates and structural sections, that a sharp decrease in impact values occur below the temperature at which 15 ft-lb occurs and for standardization, steel under impact is considered ductile above this temperature and brittle below. Fracture face is generally fibrous above 15 ft-lb, below this value being crystalline. This point at which a steel has an impact value of 15 ft-lb is referred to as the transition temperature (transition from ductile to brittle steel). If one said that Steel A had a transition temperature of 20 F and steel B had a transition

Figure 22 — Weld hardening of ½-in. plates of carbon steels with and without preheating.

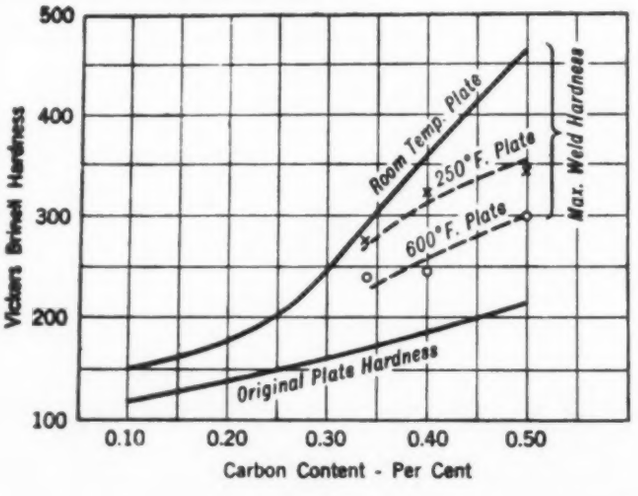


TABLE II

Effect of Some Production Variables on Charpy V-Notch Transition Temperatures (15 ft-lb) of Semi-killed Mild Steel Plate (from Partial Regression Lines) C 0.10 to 0.20 Per Cent, Si 0.020 to 0.070 Per Cent

Finishing temperature, F	Transition temperature, F (15 ft-lb)	Plate thickness, (in.)	Transition temperature, F (15 ft-lb)	Grain size gr per in. ASTM		Transition temperature, F (15 ft-lb)	Mn per cent	Transition temperature, F (15 ft-lb)	P per cent	Transition temperature, F (15 ft-lb)	Ni per cent	Transition temperature, F (15 ft-lb)
1500	18	0.4	38	16	5	100	0.20	82	0.010	43	0.10	64
1600	32	0.6	45	32	6	77	0.30	73	0.020	48	0.20	55
1700	45	0.8	52	64	7	37	0.40	64	0.030	53	0.30	46
1800	54	1.0	59	128	8	14	0.50	55	0.040	59	0.40	37
1900	61	1.2	66	..	..	..	0.60	46	0.050	64	..	..
2000	64	1.4	73	..	..	..	0.70	37	...	..	..	..
..	..	1.5	77	..	..	..	0.80	28	...	..	..	..

TABLE III

Charpy V-Notch Impact Strength (ft-lb) and Crystallinity (Per Cent Brittle, Non-fibrous Fracture) for a Typical A-131 Class C Steel Plate C 0.19, P 0.017, S 0.035, Mn 0.69, Si 0.175—Plate Thickness 1⅛ in. Normalized

Test temperature C	Test temperature F	Impact strength (ft-lb)	Crystallinity (per cent)
+20	68	74	20
0	32	52	50
−20	− 4	36	70
−40	−40	22	90
−60	−76	6	100

Transition temperature (15 ft-lb) is −45 C (−49 F)

temperature of 0 F, the latter would have higher impact strength. As the temperature at which 15 ft-lb occurs is lower in steel B it follows that at any given temperature steel B would have higher impact values.

Of the several inherent steel characteristics affecting impact properties the first we will consider is chemistry.

Carbon raises the ductility transition temperature (that is, lowers impact values) about 2 to 4 F for each 0.01 per cent increase. Therefore, if all other characteristics are equal, the lower the carbon is, the lower the transition temperature. Carbon, of course, is present to increase strength, and if the carbon is dropped, manganese can be added as a strengthener. Manganese has an appreciable beneficial effect on the transition temperature; generally each 0.01 per cent increase in manganese content up to 1.5 per cent Mn lowers the transition temperature 0.75 to 1 F.

Phosphorous and sulphur, both of which are embrittling to steel under most tests and conditions, have a detrimental effect on impact strength.

Silicon and aluminum have a beneficial effect on impact strength. This effect is not in properties imparted to the steel by these elements but their action in steelmaking in that they are deoxidizers. Killed steel is considerably superior in impact strength to rimmed or semi-killed types and in the case of aluminum the fine grained steels are higher in impact strength. The production of fine grained steel in itself is not always sufficient reason for increased impact values because size of section and finishing temperatures can produce a reasonably coarse grain size and a normalizing treatment is necessary to produce the fine grain. Table II illustrates effect of some production variables on Charpy V notch transition temperature. Table III gives some Charpy V notch values for typical AISI Class C plate. Table IV gives impact strength and transition temperature for various grades of steel, effect of Mn/C, ratio killing, grain refining and normalizing.

WELD METALLURGY

Many failures are caused by faulty weld technique. The most frequent failures by far occur due to weld hardening. Weld hardening is simply localized heat treatment of the weldment due to the welding rod heat being rapidly absorbed by adjacent cold metal. It is no exaggeration to say that the maximum hardness obtainable on any steel can be obtained with a poor welding practice. The hardening of steel, either done deliberately in the heat treatment shop or inadvertently such as in welding, occurs proportionately with the cooling rate from above the critical temperature; in other words the faster the cooling action, such as in a liquid quench, the greater the hardness developed. In weldments on higher carbon steels, it is very common in the microscope to see underbead hardening of the base metal which shows up as the brittle microconstituent martensite having a hardness value of Rockwell C 60 or higher. Such a structure, when occurring at an electrode undercut or some other area of high stress can lead to early cracking and ultimate failure because of its brittleness.

The best precaution in avoiding weld hardening is the use of material of low hardenability. Preheating is employed with higher carbon steels with which hardening can occur. By preheating the weldment, temperature gradients are minimized, cooling rates retarded, therefore less hardening occurs. It should be said that post-heat treatment or stress relieving is not a substitution for preheating. Stress relieving is employed

TABLE IV

Charpy V-Notch Impact Strength (0 F) and Transition Temperature (15 ft-lb) for Various Grades (including ND 1–IV Steels) to Show Effect of Mn/C, Killing with Si, Grain Refining and Normalizing

Grade	C	Mn	Mn/C	Ultimate tensile strength (psi)	Condition	Impact strength (ft-lb at 0 F)	Transition temperature F (15 ft-lb)
Mild steel	0.20	0.50	2.5:1	61,600	As-rolled	8	+ 30
Low C, high Mn (semi-killed, low Si)	0.13	1.10	8:1	60,100	As-rolled	19	− 8
Low C, high Mn (semi-killed, low Si)	0.13	1.10	8:1	...	Normalized	37	− 31
Low C, high Mn (killed, high Si)	0.13	1.10	8:1	...	Normalized	50	− 50
Low C, high Mn (grain refined, Al)	0.13	1.10	8:1	...	Normalized	57	−150

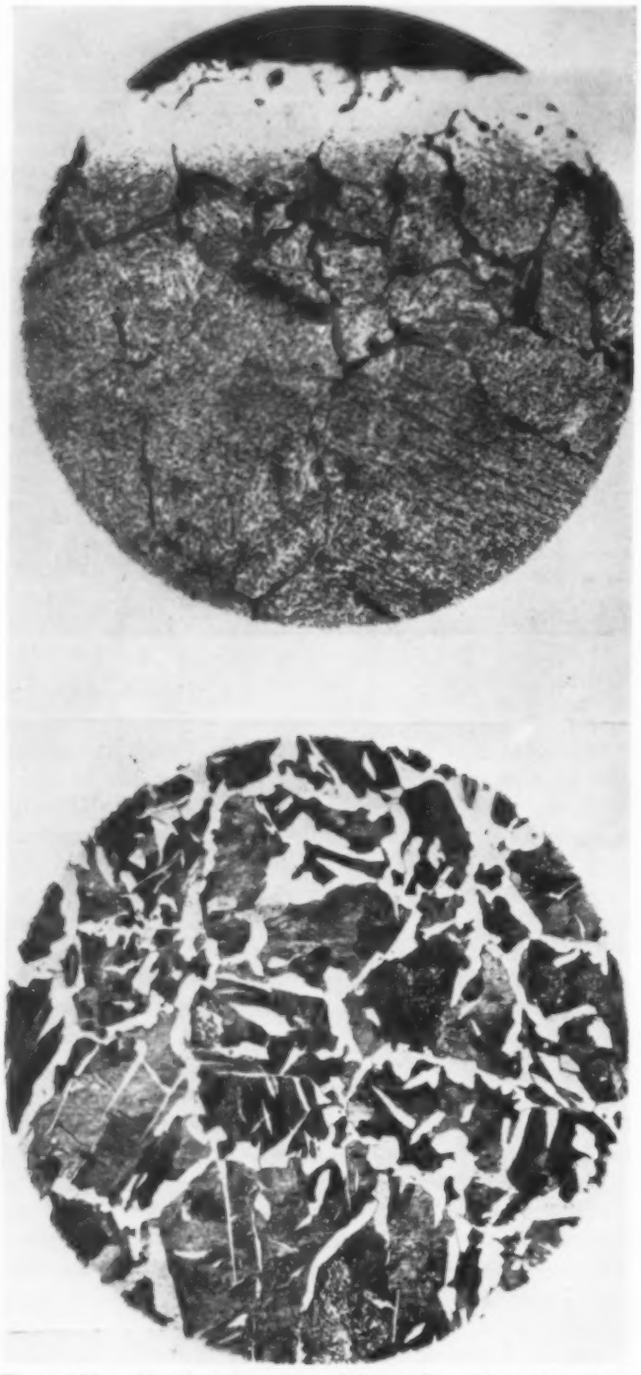


Figure 23 — Hardened martensitic surface structure, top, and normal structure remote from heat affected zone, below, shows hardening which resulted from torch cutting a 0.40 C, 4-in. plate section. This was a crane bale which fractured in service from the embrittlement.

to relieve the high residual tensile stresses from expansion and contraction of a weldment and also serves the purpose of tempering (or drawing back) any hardening developed in welding. Tests have shown that preheating is far more beneficial in avoiding hardening, particularly in view of the fact that with higher carbon steels, weld hardening to the point of underbead cracking can occur and no subsequent heat treatment can cure this.

The higher the carbon and alloy content of the steel of course, the higher is its hardenability. Therefore, as carbon content increases, the preheat must be

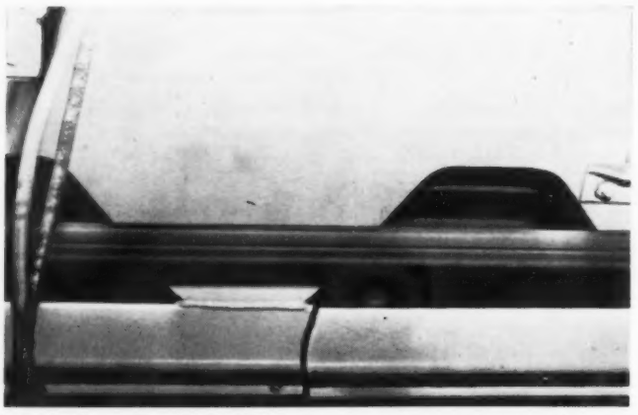


Figure 24 — Fractured crane runway beam, showing breakage which has taken place in the bottom T rail immediately adjacent to where it is welded to the supporting beam.

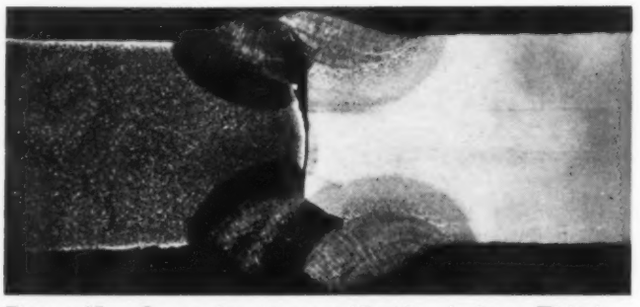


Figure 25 — Approximate magnification is four. This is a face-on (transverse) view of weld joining top and bottom rails. Top is low carbon (0.20 per cent), bottom is 0.50 C steel for abrasion resistance of trolley wheels. Note underbead hardening.

Figure 26 — Approximate magnification is 6½. Face on a longitudinal section through the junction of the beam and rail where weld runs out shows the crack in the bottom rail in relationship to the weld hardened zone. The structure at and near the point where the crack developed is martensite with Rockwell hardness C60-65.

increased. The rule of thumb usually applied is 100 F of preheat for 10 points of carbon, preheat not being necessary for 0.10 per cent carbon steel or lower. Another factor which greatly influences the extent of weld hardening is the mass of metal. The heavier the section, the greater the chill on the heat affected zone and therefore the hardness pickup increases. In sections over 2 in. a 100 F in preheat is generally used for each additional inch of thickness.

CRANE RUNWAY BEAM FAILURE

We have had considerable experience with breakages of crane runway beams in our finishing plants. These breakages all occurred at welds, and an explanation should be given of their construction. The top main beam is a T, the vertical leg of the T has semi-circular cutouts for weight saving, the portions of this leg remaining are referred to as teeth and are approximately 4 in. in length. These teeth are welded to the bottom beam which carries the trolley. The top beam is 0.20 per cent C, A7 ordinary structural grade, the bottom beam is 0.60 per cent C steel for abrasion resistance from the trolley wheels. Fatigue cracks which led to several failures were present on the bottom rail of several installations, Figure 24. These cracks occurred at the running-out portion or toe of the weld at the end of the teeth which was welded last. Subsequent investigation showed excessive weld hardening checking as high as RC 65–66 in these areas compared to RC 30 in unaffected base metal hardness, Figure 25. Failure, of course, was due to poor welding technique, particularly lack of preheat, Figure 26. Figure 26 is a longitudinal section through the junction of the beam and rail showing microscopic crack which has developed at the toe of the weld. Hardness values are as follows: T-rail—Rockwell C 25, martensitic area (underbead hardening)—Rockwell C 56–58. These values illustrate absolutely no preheating of the weldment and certainly no post-heat treatment. In addition to this it was established in comparison with competitors satisfactory beams that the "feathering-out" of the weld bead is poor practice in that this final bead is laid on cold metal and does not receive either the preheat or subsequent tempering effect of multiple bead laying as it does in the center of the weldment. Cracking of the T-rail in the almost completely hardened condition would easily be initiated by the slight vibratory stresses induced in operation, although in many cases spontaneous underbead cracking was present in martensitic areas. Welding recommendations were made suggesting: (a) beveling of teeth on the top rail, (b) jig setting-up of both rails and preheating to 500 F, (c) weld to start at center horizontal line of tooth, wrap around both ends and double back to starting point, (d) low hydrogen rod. ▲

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

No September Meeting

BUFFALO SECTION

No September Meeting

CANTON SECTION

No September Meeting

CHICAGO SECTION

No September Meeting

CLEVELAND SECTION

No September Meeting

DETROIT SECTION

No September Meeting

LOS ANGELES SECTION

Monday, September 14, 1959—Social Hour 6:15 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Expansion of Electrolytic Tinning Facilities at Pittsburg Works," by R. L. Dowell, Assistant to General Superintendent, Columbia-Geneva Steel Div., United States Steel Corp., Pittsburg, Calif.

Michael's Restaurant, 6309 E. Washington, Los Angeles, Calif.

PHILADELPHIA SECTION

No September Meeting

PITTSBURGH SECTION

No September Meeting

ST. LOUIS SECTION

Wednesday, September 23, 1959—7:00 P.M. (For Trip). (No Dinner or Social Hour)

Inspection Trip—Through Plant No. 10, Falstaff Brewing Co., St. Louis, Mo.

SAN FRANCISCO SECTION

Tuesday, September 22, 1959—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Bethlehem Steel Co. Night

"Personal Experiences During Visit to Soviet Union Steel Industry," by F. S. Eckhardt, Assistant to Vice President, Bethlehem Steel Co., Bethlehem, Pa.

Shattuck Hotel, Shattuck & Alston Way, Berkeley, Calif.

UTAH SECTION

Monday, September 14, 1959—Social Hour 6:30 P.M., Dinner 7:30 P.M., Meeting 8:30 P.M.

Details Not Available

Grandview Cafe, Provo, Utah

YOUNGSTOWN SECTION

No September Meeting

Experience With Self-Fluxing Sinter at The Steel Co. of Canada, Limited

by J. S. McMahan, Superintendent, Blast Furnaces, The Steel Co. of Canada, Limited, Hamilton, Ontario

. . . . presented before general meeting of the American Iron and Steel Institute in New York, May 27, 1959 . . . . the present high capital cost of blast furnace may justify use of self-fluxing sinter to increase furnace production over that of natural ore practice or permit installation of a smaller furnace for a given tonnage production rate . . . .

THE increase in blast furnace output as a result of the use of burden preparation has been the subject of speculation and study for many years.

The availability of rich ores and plentiful fuel resources on the American continent has promoted the development of a natural ore practice rather than a full exploitation of burden preparation. The present high capital cost of blast furnaces, however, has increased the necessity for the study and adoption of some form of burden preparation.

The preparation of a blast furnace burden is concerned mainly with its iron and flux bearing parts and may have the following aspects:

1. Physical preparation.
2. Chemical preparation.
3. Physical and chemical preparation.

Every type of burden preparation always has in view several characteristics which are essential for efficient blast furnace operation:

1. A sufficiently high and uniform over-all permeability of the stock.
2. Satisfactory reducibility of the iron bearing materials.
3. Uniformity of the burden, both physical and chemical.
4. Reduction of the thermal load of the blast furnace.

The first factor is particularly important for efficient blast furnace operation. A relatively, high permeability,

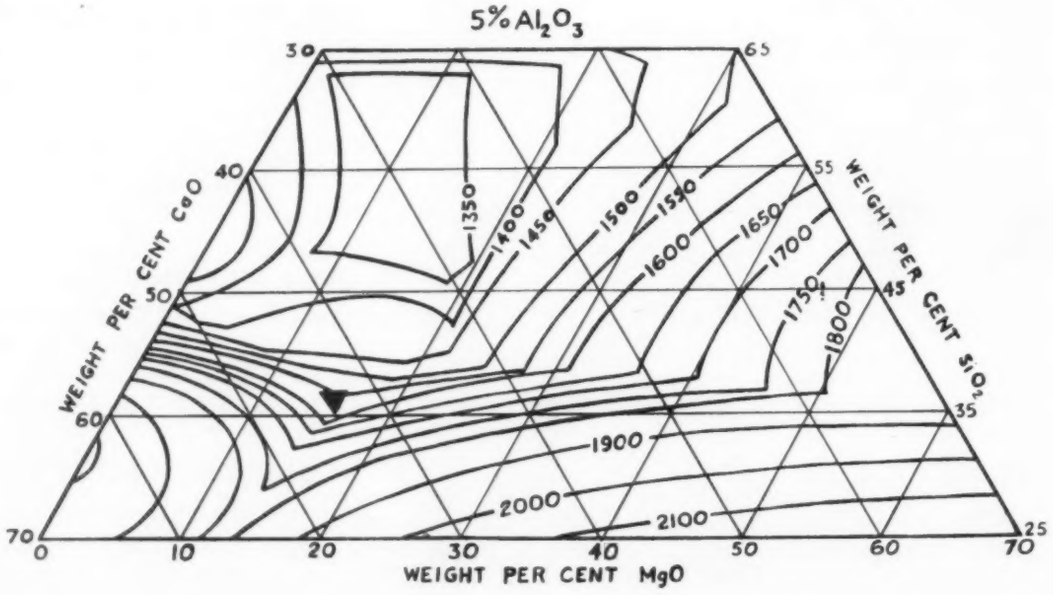


Figure 1 — Optimum blast furnace slag composition (triangle) at 5 per cent Al_2O_3 taken from paper by Osborn.

uniform over the cross section of the furnace, will facilitate the heat exchange between the gases and solids and the reduction of the iron oxides, and will be conducive to a relatively higher wind rate.

The furnace gases, in traveling from the tuyeres to the stock line, will pass through the plastic zone and then through the granular bed above it. Thus, a correct chemical composition of the burden to ensure a narrow plastic zone of low viscosity as well as a proper granulometric composition above the plastic zone are both important to good permeability. This is of increasing importance should the amount of coke per unit of ore decrease since the permeability due to the coke would be lessened.

A sufficiently high reducibility of the iron bearing material will increase the amount of indirect reduction and allow a higher throughput rate without upsetting the parameters of the plastic zone and the operation of the furnace. The reducibility should be considered not for a sample of laboratory size only, but as an over-all characteristic of the material in the furnace stack. Thus the reducibility of the burden is a function not only of the chemical and mineralogical composition of its iron bearing materials, but also of its permeability.

Uniformity of the burden implies a minimum number of components in the charge. Ideally, the burden should consist of only two components: the iron and flux bearing material, and the reducing and combustible agent. The proper permeability, reducibility and uniformity of the burden ensures the maximum reduction of the burden before it reaches its softening temperature, thus resulting in a narrower plastic zone and allowing increased wind rates to be used.

The last characteristic of effective burden preparation, the reduction of the thermal load of the blast furnace, can be accomplished by the removal of volatiles and by the decomposition of carbonates outside of the blast furnace. In addition to the saving of the heat of vaporization and decomposition, the elimination of the carbon dioxide from the charge by the decomposition of the carbonates will reduce solution losses in the upper levels of the stack and hence further reduce coke consumption.

At present, sintering and pelletizing are the two methods most widely used for burden preparation. In either method, the flux required for proper desulphurization of the pig iron can be incorporated in the product and the size of the product can be controlled.

Self-fluxing sinter composition—A blast furnace slag to be most effective must be completely liquid at the temperature to which it is heated in the furnace. This temperature range in the case of the slags obtained at The Steel Co. of Canada is 2700 F (1482 C) to 2850 F (1566 C), temperature of the flush slag. Practical slag compositions, therefore, are ones with liquidus temperatures under 2700 F (1482 C).

Theoretically, the optimum composition of a slag for any particular Al_2O_3 concentration lies at a point of minimum SiO_2 content, is not too close to an area of crowding isotherms over 2700 F (1482 C) and, if possible, near or on a plateau region of the ternary CaO—SiO_2—MgO diagram (see Figure 1). Such a slag will have a maximum desulphurizing power and will not be too sensitive to eventual fluctuations in chemical composition.

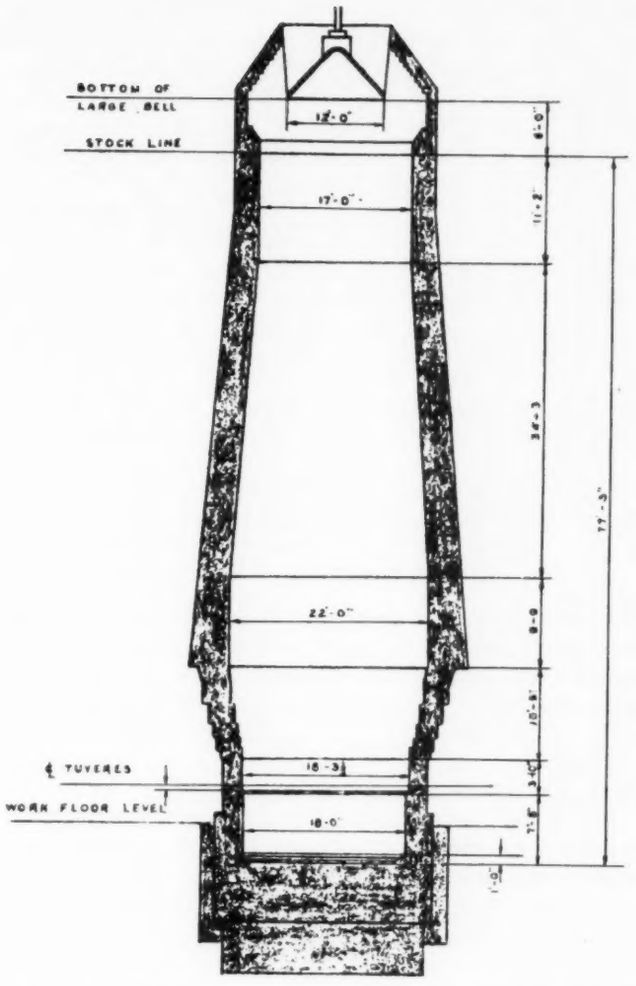


Figure 2 — This is an outline drawing of Stelco blast furnace "B."

Since minor constituents in the slag tend to lower the liquidus temperature below that which would prevail if the slag were composed of only the four major components, the minimum liquidus temperature of an optimum slag can be safely raised to 2750 F (1510 C) or even 2800 F, for it has been indicated by E. F. Osborn (1)* that liquidus temperature depression from minor constituents is of the magnitude of about 180 F (100 C). The composition of optimum blast furnace slags with different contents of Al_2O_3 (0 to 35 per cent) has been suggested by Osborn (1). His optimum slag for the five per cent Al_2O_3 level is represented by the solid triangle in Figure 1.

A truly self-fluxing sinter is a sinter which can be charged to a furnace along with coke to yield upon smelting a slag having a low viscosity and having a suitable composition for proper desulphurization of the pig iron so that the charge would consist only of sinter and coke.

A burden of this type requires a sinter of a consistently uniform (within a certain range of tolerance) chemical composition so as to enable the operators to properly control the sulphur. Should the inadequacy or lack of bedding facilities and proportioning devices in the sintering plant make an adequate control of the chemical composition of the sinter impracticable, the

* Numbers in parentheses refer to bibliography at end of paper.

production of two types of sinter, one slightly basic and the other slightly acid, may be desirable. Both sinters would be charged into the furnace and their different proportioning in the charge would provide an additional possibility of control on the furnace. This method would not interfere with the fundamental principles of a fully prepared and uniform burden.

In the initial development of a truly self-fluxing sinter, it was felt that the adoption of Osborn's optimum slag composition would be a logical starting point, fully realizing that the coke ash when combined with the flux portion of the sinter would tend to make the slag more siliceous and to raise its alumina content.

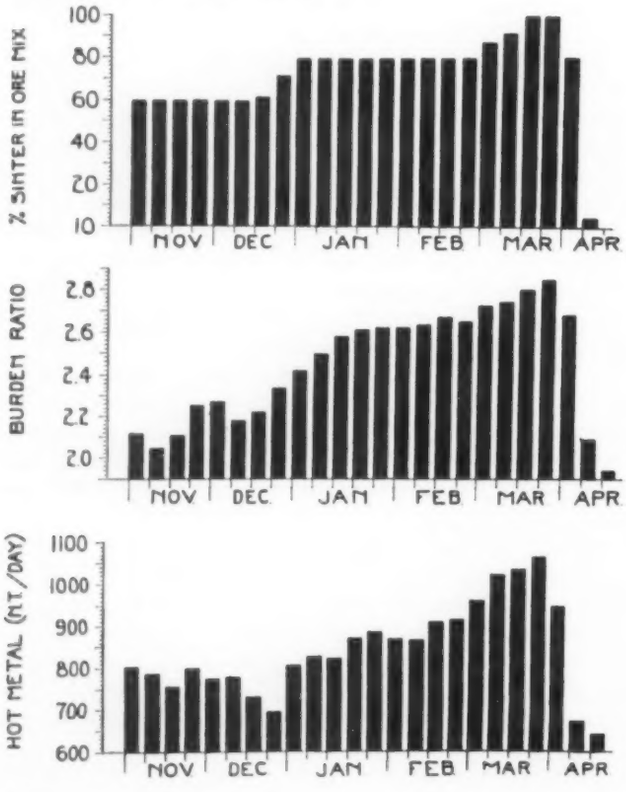
Description of trials—The Steel Co. of Canada has four blast furnaces:

1. "A" furnace, hearth diameter = 11 ft.
2. "B" furnace, hearth diameter = 18 ft.
3. "C" furnace, hearth diameter = 23 ft-6 in.
4. "D" furnace, hearth diameter = 28 ft.

and one sintering unit capable of producing about 2200 net tons of sinter per day. "B" furnace was selected for the 100 per cent self-fluxing sinter trial as the sinter plant has only sufficient capacity to supply this furnace. ("A" furnace is used for the production of "merchant iron.") The dimensions of "B" furnace are shown in Figure 2.

At the commencement of the sinter trial, "B" furnace was operating on a 60 per cent sinter burden, the sinter used being only partially fluxed. The amount of self-fluxing sinter and the total amount of sinter in the burden were increased gradually throughout the trial until a 100 per cent self-fluxing sinter burden was attained. The trial was terminated after reverting to a

Figure 3 — These bar type graphs illustrate data on "B" blast furnace practice during test.



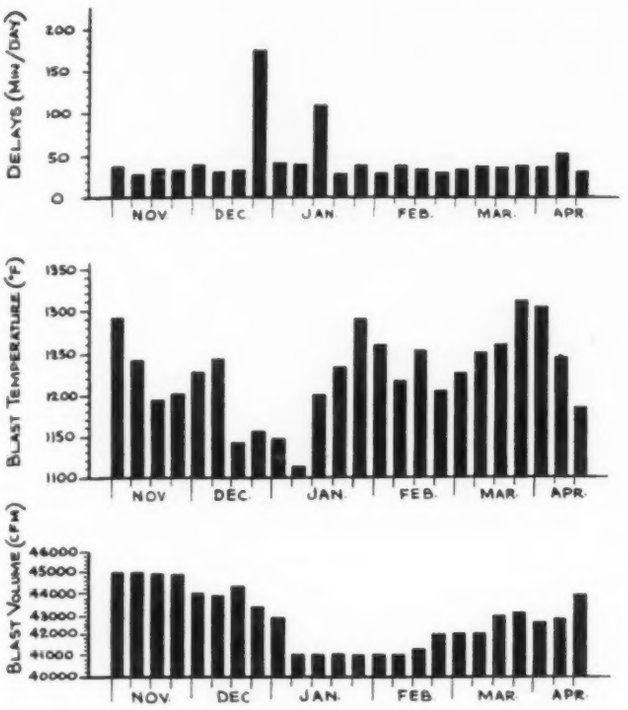


Figure 4 — Blast volume, blast temperature and delays for "B" blast furnace during test period.

natural ore practice which served as a basis for evaluating the performance obtained with the 100 per cent sinter practice.

The trial period lasted from November 1, 1957 to April 17, 1958. The data obtained from the trial period have been divided into 24 seven-day periods, the results being expressed as daily averages. The division of the data in this manner was convenient but in some instances resulted in the averaging of mixed practices, i.e., during the March 28–April 3 period both 100 per cent sinter and natural ore practices were employed.

PRODUCTION RATE AND OPERATING CONDITIONS

From November 1, 1957 to December 5, 1957, the burden consisted of 60 per cent partially-fluxed sinter (dolomite sinter), the remainder being a mixture of natural ores. From December 6, 1957 to March 31, 1958, the amount of sinter in the burden was progressively increased and the amount of truly self-fluxing sinter (calcite sinter) in the sinter part of the burden was also increased. Between February 21, 1958 and March 31, 1958, all of the flux required was contained in the sinter. After March 31, 1958, the use of sinter in the burden was discontinued. See Figure 3.

Production rate—It appears from Figure 3 that as the amount of sinter in the burden was increased the production rate also increased. By comparing the production rate of 1073 tons per day obtained with a 100 per cent sinter burden during the period March 21 to March 27 with the production rate of 653 tons per day obtained with the natural ore burden during the period April 11 to April 17, it may be seen that a gain of 64.3 per cent in production was realized. The highest production rate for any single day occurred on March 31 which was the last day on which a 100 per cent sinter burden was employed. The production rate

obtained on this day was 1140 tons which represents an increase of 74.6 per cent over the April 11 to April 17 average. The average of 653 tons per day is representative of the production rate obtained from "B" Furnace as the 1952 to 1955 average was 650 tons per day, no self-fluxing sinter being used during those years.

From November 1 to December 31, both the wind flow and temperature were decreased, but the production rate remained relatively constant except for the low production obtained during the period December 20 to December 26, i.e., 704 tons per day. The operating delays for this latter period were considerable, averaging 174 minutes per day. See Figure 4. It would appear that the decrease in production that would be expected from lower wind flow and temperature was offset by the increased amount of self-fluxing sinter and by the slightly higher burden ratios used during this time.

Burden ratio—It is the practice at The Steel Co. of Canada to maintain a constant weight of coke in the charge so that the skip cars are always filled to the safe limit with coke, and to vary the weight of ore and stone according to the demands of the furnace. Increases in the burden ratio are made cautiously and decreases can be and are made rapidly, the changes in the burden ratio being made only by changes in the ore weight. From Figure 3, it may be seen that the burden ratio was increased by an amount which closely corresponds to the increases in the proportion of sinter contained in the burden. High sinter burdens permit the use of higher burden ratios.

Blast—The flush slag temperature was estimated visually and the blast temperature varied accordingly. The blast temperature was also varied in order to control the silicon content of the pig iron, being increased when the silicon content fell and decreased when the silicon content rose. Because the blast temperature is used as a control, it was not held at any particular level during the trial. It was, however, at or below 1300 F (704 C) in most instances as temperatures above 1300 F (704 C) cannot be maintained owing to the limited stove capacity. See Figure 4.

The operation of the blast furnace with a high sinter burden was noticeably different than that with a natural ore burden as the stock descended smoothly without hanging despite the fact that high blast temperatures were employed.

During the month of December the temperature of the top gas was irregular, often rising abruptly to temperatures as high as 900 F (482 C). Because of these frequent extremes in the temperature of the top gas, the blast volume was reduced from 45,000 to 41,000 cfm. As a result of this change the average temperature of the top gas was lower, and the abrupt increases in the temperature occurred less frequently.

The wide fluctuations in the temperature of the top gas was possibly due to the incomplete readjustment of the furnace lines to the relatively rapid changes in burdening which tended to cause channeling of the gases and hanging of the stock.

During the latter part of the trial the wind volume was again increased for the operation of the furnace had been smooth: the stock usually descending evenly and the blast pressure for the most part remaining relatively uniform.

It has been the practice for several years at The Steel Co. of Canada to add steam to the blast. The steam is injected into the cold blast main from a 2-in. steam line through any or all of the three connections: ¾, 1, and 1¼ in. During the latter part of the trial all three connections were fully opened. Neither the amount of moisture in the blast nor the amount of steam injected into the main during the trial could be estimated as no accurate metering instruments were available.

The blast pressures recorded during the trial period did not show any marked trend either to increase or to decrease as the proportion of sinter in the burden changed. The average blast pressure for the trial period, however, was somewhat higher than was the average for the year 1956. In general, as already mentioned, the operation of the furnace was smooth, the stock usually descended evenly and the blast pressure remained relatively uniform over the test period.

SINTER

Two main types of sinter were used during the trial period and have been named "dolomite" sinter and "calcite" sinter. The dolomite sinter, as the name suggests, is produced from a sinter mix containing dolomite fines. The calcite sinter, however, is produced from a mix containing both dolomite and calcite fines.

Dolomite sinter—Dolomite sinter was first produced on April 1, 1956. After a few trial periods a sinter mix containing 18 per cent dolomite fines was decided upon and has remained at this level for most of the time since then. Table I lists the average amount of dolomite fines and coke breeze used in the dolomite sinter mix and the average analysis of the sinter produced during the 24-week trial period.

Dolomite sinter is only partially fluxed and if more dolomite were added to the sinter mix, the resulting sinter could still not be strictly considered self-fluxing as the blast furnace slag that would be obtained would have too high a magnesia content. The work of Osborn et al (1), Holbrook and Joseph (2), and Holbrook (3), showed that the optimum magnesia content for the type of slag obtained at The Steel Co. of Canada would be between 12 and 16 per cent, where the per cents of $SiO_2 + CaO + MgO + Al_2O_3$ equals 100 per cent. The slag portion of the dolomite sinter as presently produced has an average magnesia content of 19.35 per cent. See bracketed values in Table I.

Calcite sinter—Calcite sinter was produced in December, 1957, and was the first attempt at making a truly self-fluxing sinter. The sinter mix initially contained 15 per cent dolomite and 10 per cent calcite. The amount of dolomite in the mix was later reduced to 11 per cent when after using an 80 per cent calcite sinter burden it was found that the calcite sinter contained sufficient limestone and dolomite to flux the coke ash and the gangue of the natural ore in the burden and would thus be expected to give a very basic slag upon using the proposed 100 per cent calcite sinter burden.

The average composition of the sinter mixes and the average analyses of the two types of calcite sinter produced are listed in Table II.

Despite the reduction in dolomite, No. 2 calcite

TABLE I
Dolomite Sinter

Mix per cent dolomite in sinter	Per cent coke breeze in sinter mix	Sinter analysis						
		Fe, per cent	SiO_2, per cent	Al_2O_3, per cent	CaO, per cent	MgO, per cent	FeO, per cent	Basicity ratio
17.7	6.6	53.08	10.49	1.57	7.57	4.71	12.9	1.02
	...	...	(43.10)	(6.45)	(31.10)	(19.35)	...	...

TABLE II
Calcite Sinters

	Calcite in mix, per cent	Dolomite in mix, per cent	Breeze in mix, per cent	Fe, per cent	SiO_2, per cent	Al_2O_3, per cent	CaO, per cent	MgO, per cent	FeO, per cent	Basicity ratio
No. 1	10.3	14.8	6.7	51.03	10.08	1.40	11.61	4.43	11.78	1.40
No. 2	10.3	10.8	7.3	52.53	8.98	1.84	10.15	3.96	11.76	1.30

sinter was still found to yield slightly basic blast furnace slags. Since the dolomite sinter on the other hand was slightly acid, it was possible to control the sulphur content of the hot metal by varying the proportions of these sinters in the burden when the charge consisted only of sinter and coke. A change in the proportion of these sinters in the burden had to be made quite frequently toward the end of the trial as their chemical analyses could not be maintained constant because of a lack of suitable feed controls in the sinter plant.

The development of a truly self-fluxing sinter can be approached in two ways:

1. A desirable composition of the blast furnace slag is selected and then, knowing the chemical composition of the elements of the burden and assuming a certain coke rate, the composition of a sinter that would produce such a slag is calculated. This approach either assumes an advance knowledge of the coke rate or necessitates calculations for several most likely coke rates with the final selection done after some furnace trials.

2. The composition of the slag forming part of the sinter is selected according to a quaternary diagram so that its dilution with SiO_2 and Al_2O_3 (at any reasonable coke rate) from coke ash will place the composition of the final blast furnace slags in a desirable area of the diagram. This approach does not require an advance knowledge of the coke rate.

For both cases Osborn's phase diagrams can be used. The second approach was used in the present work.

The composition of calcite sinter No. 1 was derived from the optimum slag composition for a five per cent Al_2O_3 slag shown in Figure 1, namely:

	Al_2O_3	CaO	MgO	SiO_2
Osborn's ideal	5	43	16	36
Calcite sinter No. 1 (average)	5.09	42.19	16.00	36.63

It may be seen that in practice Osborn's ideal slag composition was closely approximated. Although his ideal slag composition has a desulphurizing power greater than that required in practice, it provided a basis for determining the composition of the preliminary self-fluxing sinter mix.

A dilution of Osborn's ideal slag with SiO_2 and Al_2O_3 from coke would also remove the ultimate blast furnace slag from the area of a relative crowding of isotherms and make it less sensitive to fluctuations in composition.

Samples of calcite sinter were obtained daily from the blast furnace bins and their bulk density and size grading determined. From Table III it may be seen that there is no significant difference in these properties of the two types of calcite sinter used. (No data are available for comparison with dolomite sinter.)

COKE

Physical properties—As "D" furnace was down for relining at the commencement of the trial and was not put into operation until toward the middle of the trial period, the coking time employed was altered to a considerable extent (24 to 17 hr) in order to adjust the output of the coke ovens to the changing demands for coke by the blast furnaces. This coincidence provided an opportunity to observe the influence of coking time upon the physical properties of coke, and the influence of the properties of the coke upon the operation of the blast furnace.

From Figure 5, it is interesting to note that the physical properties of the coke as assessed by the ASTM shatter, tumbler and porosity tests did not change in a manner related to coking time. The gross coke mean size, however, varied directly with net coking time and indirectly with flue temperature, as may be seen in Figure 6.

It would appear that comparison of the properties of the coke, as presently measured, with the production rate obtained in the blast furnace, Figure 3, that within the variation in coke properties obtained, the coke does not seem to have any influence upon the production rate.

Coke rate—The coke rate was reduced from about 1800 lb per ton of pig iron when using an ore burden to nearly 1200 lb per ton of pig iron when using a sinter

TABLE III
Physical Properties of Calcite Sinters

Type	Bulk density, lb per ft^3	Mean size, in.	−⅛ in., per cent
1	102.4	0.46	7.0
2	103.2	0.45	8.9

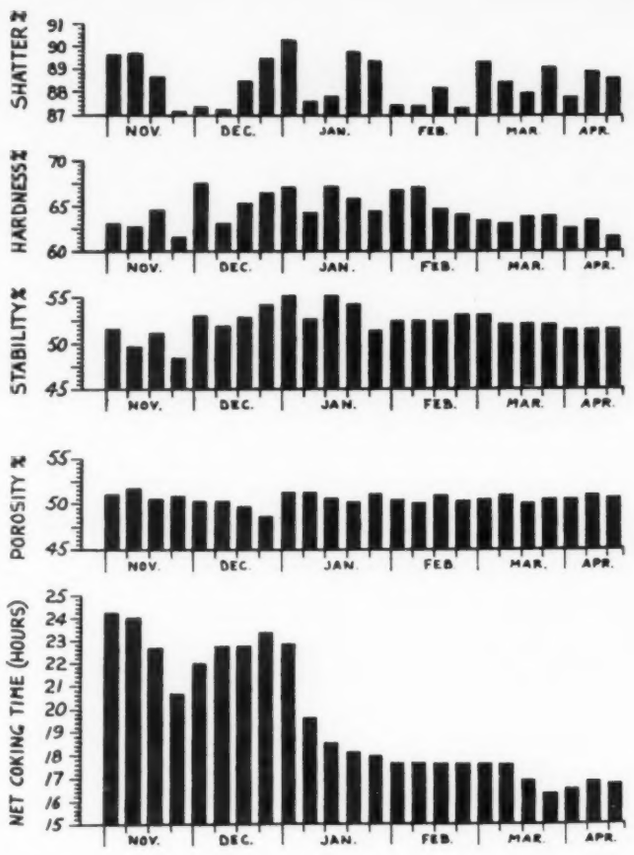


Figure 5 — Coke oven data during the test period.

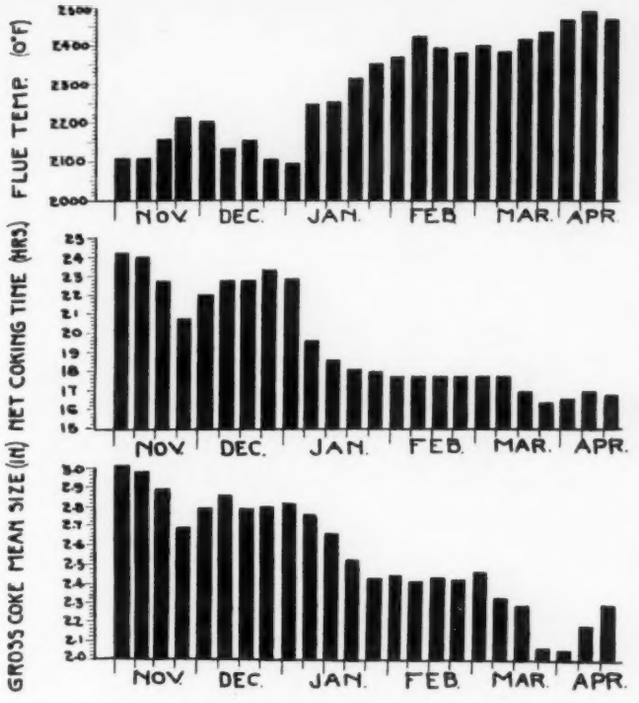


Figure 6 — Coke size, net coking time and flue temperature for the test period.

burden. This represents a saving of 600 lb of coke per ton of pig iron. The reduction in fuel consumption actually is not this large as the amount of coke breeze used to make the sinter must be taken into account. If the cost of coke breeze were deemed to be the same as blast furnace coke there would still be a net saving of about 250 lb per ton of pig iron. See Figure 7.

TOP GAS AND FLUE DUST

Top gas—The CO/CO_2 ratio of the top gas and the top gas temperature are considered by the industry to indexes of the efficiency of furnace operation: a high ratio and temperature indicating low efficiency, while a low ratio and temperature indicates a high efficiency. From Figure 8, it may be seen that on this premise the efficiency of "B" furnace increased with the increased use of sinter. It follows that a low heating value of the top gas is also an index of high efficiency, Figure 8, and with improved blast furnace efficiency it may be necessary to enrich the top gas with some coke oven gas in order that the blast furnace gas will be suitable for use as a fuel.

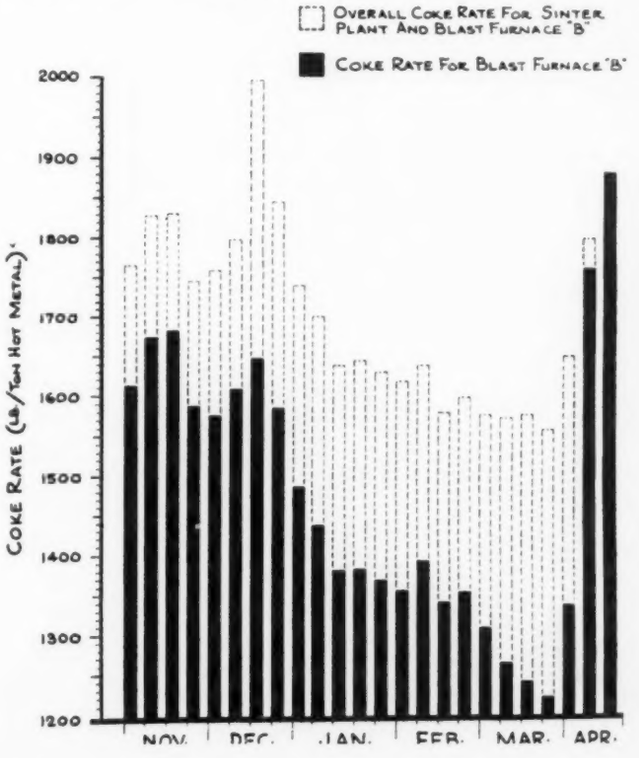
Flue dust—The advantages of using sinter appear to be many as in addition to increasing the production and decreasing the coke rates, the amount of flue dust produced was drastically decreased. The normal amounts of 60 or more lb of flue dust per ton of pig iron were reduced to 28 to 29 lb per ton.

The carbon content of the flue dust increased as the amount of flue dust decreased. This is to be expected as relatively the same amount of coke dust would be blown out with the gas stream, but sinter being apparently less prone to the formation of fines than ores are, did not contribute greatly to the dust load. This is further borne out by the fact that the iron content of the flue dust was much lower.

IRON COMPOSITION

Manganese—The manganese content of the hot metal was reduced from the normal values of greater than one per cent to as low as 0.22 per cent during the

Figure 7 — Coke rate data for test period.



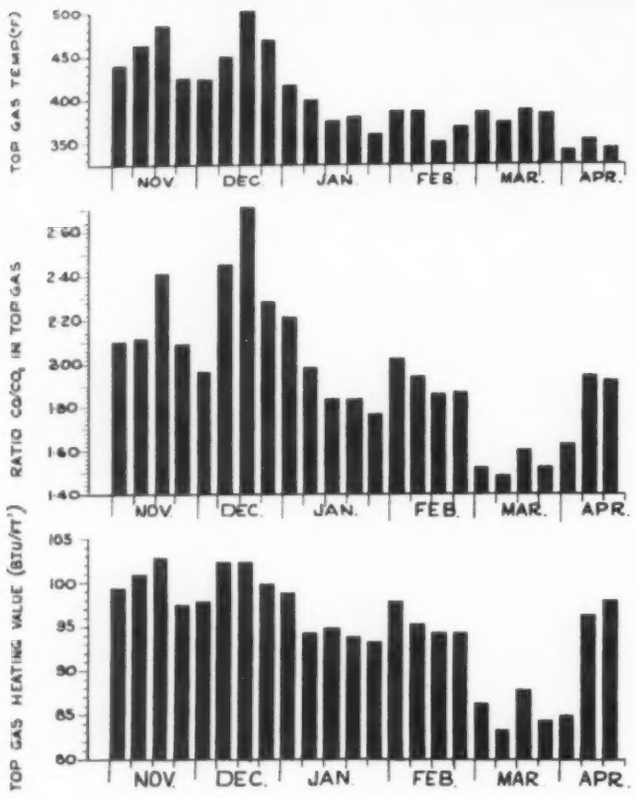


Figure 8 — Heating gas data for "B" blast furnace.

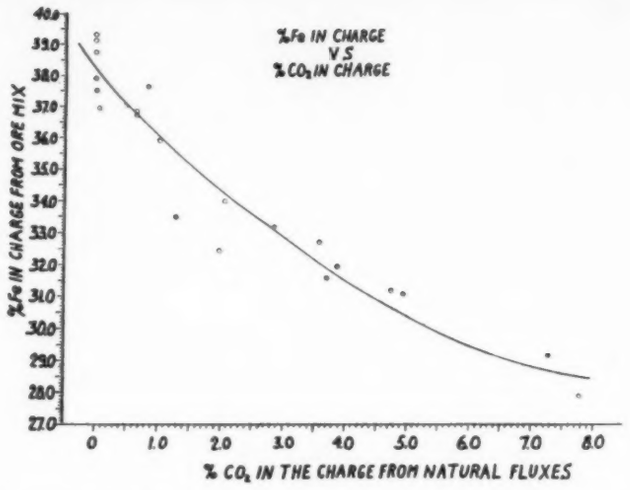


Figure 9 — Per cent iron in charge vs per cent carbon dioxide from natural fluxes in charge for blast furnace "B."

trial. The reduced manganese was the result of the elimination of manganese bearing iron ore and open hearth slag from the charge for a few periods during the trial. The reduced manganese in the charge did not cause any discernible changes in the blast furnace operations.

The reduction in the manganese content of the hot metal by some one per cent will decrease the amount of heat liberated as a result of the oxidation of manganese in the open hearth bath during the flush. This loss of heat may not affect the open hearth practice as long as the furnaces have the capacity to maintain a sufficiently high firing rate as was the case at The Steel Co. of Canada. The use of low manganese iron in furnaces having a low firing rate with no possibility of increasing the rate will have to be investigated in practice.

A study was made to determine the effect of pig iron with a low manganese content on the residual manganese and the degree of desulphurization in the open hearth. The study was carried out by comparing the data from heats where the hot metal charged had either a high or low manganese content.

In Table IV, the number of heats used in the study, the average manganese in the hot metal, the average residual manganese in the steel at tap and the weight of manganese lost during refining are listed. The difference between the average manganese content in the hot metal and in the steel for the heats studied has also been noted.

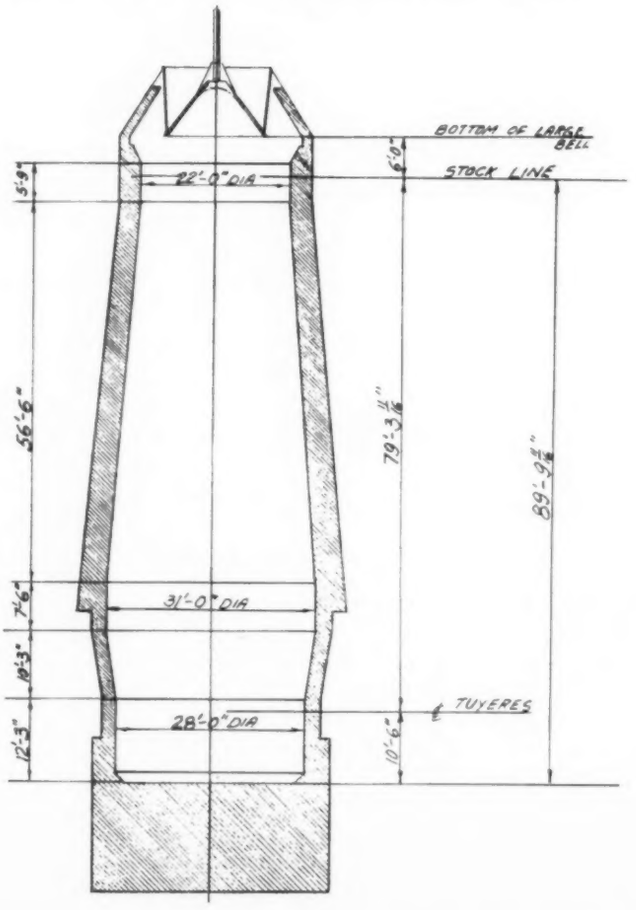
From Table IV it appears that 2½ times as much manganese is lost to the slag in the open hearth with

TABLE IV
Low and High Manganese Hot Metal Used in the Open Hearth

	Low Mn hot metal	High Mn hot metal	Difference
Number of heats*	111	90	...
Average Mn in hot metal, per cent	0.39	1.37	0.98
Average residual Mn in steel at tap, per cent	0.101	0.132	0.031
Weight loss Mn based on 100-ton heat, tons	0.294	0.753	0.459

* A 50 per cent hot metal charge was used in all cases. Scrap assumed to contain 0.4 per cent Mn.

Figure 10 — Outline drawing of Stelco blast furnace "D."



high manganese hot metal than with low manganese hot metal. It would thus be expected that the yield when using low manganese hot metal would be slightly better, i.e., approximately one additional ton of steel per 110 tons of hot metal charged or per 220 tons of steel produced.

The variation in melt sulphur was correlated with manganese and sulphur in the hot metal, and the finish ladle sulphur with manganese and sulphur at melt. Although a relationship was found between sulphur in the hot metal and sulphur at melt, and between sulphur at melt and finish sulphur, no relationship in either case was evident for manganese indicating that the difference in the manganese content of the bath obtained by changing manganese content of the hot metal did not affect desulphurization.

From all observations to date, there does not appear to be any necessity for charging manganese bearing iron ores or open hearth slag to the blast furnace. As a matter of fact the presence of fines in the open hearth slag may have a detrimental effect upon blast furnace performance.

The work of Glaskov (4) and Sherebin (5) corroborates the belief that the use of open hearth slag and production of high manganese iron is undesirable. The results obtained from the blast furnace trials which they quote, showed an increase in furnace output by some six per cent with a corresponding decrease in coke rate by approximately 5 to 6 per cent through the elimination of open hearth slag from the charge and reversion to low manganese iron.

Silicon—The silicon content of the hot metal de-

TABLE V
"B" Furnace

Date	Total coke consumed, tons per day	Coke burnt at tuyeres, tons per day	Coke for reduction of Si, tons per day	Coke for alloying iron, tons per day	Solution losses, tons per day	Per cent coke consumed above tuyeres	Top gas production		Sensible heat of top gas Btu per ton × 1000
							Cfm	Cu ft per ton	
Nov. 1–7	648.4	487.3	6.97	37.4	116.73	18.0	63,540	110,955	952.2
Nov. 8–14	661.6	490.5	9.55	36.7	124.85	18.9	63,615	113,785	1027.3
Nov. 15–21	637.0	487.9	9.56	35.4	104.14	16.3	63,300	117,040	1106.9
Nov. 22–28	638.4	487.4	8.81	37.4	104.79	16.4	63,160	110,685	917.3
Nov. 29–Dec. 5	615.0	476.0	8.01	36.3	94.69	15.4	62,045	111,600	922.7
Dec. 6–12	631.1	478.1	7.74	36.5	108.76	17.2	61,580	110,905	973.2
Dec. 13–19	608.6	482.3	7.81	34.4	84.09	13.8	61,195	116,675	1144.4
Dec. 20–26	558.6	422.8	8.00	32.7	95.10	17.0	60,440	108,685	994.0
Dec. 27–Jan. 2	609.0	462.1	9.21	38.0	99.69	16.4	59,570	102,025	829.6
Jan. 3–9	603.1	443.7	9.51	38.9	111.00	18.4	56,910	95,395	744.1
Jan. 10–16	576.4	421.6	9.80	38.7	106.30	18.4	57,525	92,325	684.3
Jan. 17–23	609.1	446.9	9.55	40.9	111.75	18.3	57,440	92,335	684.2
Jan. 24–30	614.4	444.3	8.74	41.6	119.76	19.5	57,935	90,945	638.5
Jan. 31–Feb. 6	599.1	447.2	9.83	41.0	101.07	16.9	57,730	92,655	699.2
Feb. 7–13	612.6	444.3	9.35	40.8	118.15	19.3	57,440	92,025	694.5
Feb. 14–20	618.5	448.3	9.07	42.7	118.43	19.1	57,545	88,285	606.0
Feb. 21–27	628.8	458.1	10.06	43.1	117.54	18.7	58,715	89,660	645.2
Feb. 28–Mar. 6	639.9	457.1	9.71	45.3	127.69	20.0	57,710	83,600	630.9
Mar. 7–13	657.3	455.8	9.60	48.2	143.70	21.9	57,120	77,575	567.3
Mar. 14–20	649.8	465.5	11.64	48.5	124.16	19.1	58,370	78,800	596.2
Mar. 21–27	657.2	466.4	9.84	49.9	131.06	19.9	58,480	76,630	573.8
Mar. 28–Apr. 3	644.4	461.6	9.48	44.7	128.62	20.0	58,840	86,145	574.5
Apr. 4–10	604.0	458.7	7.66	31.9	105.74	17.5	60,050	121,855	841.2
Apr. 11–17	614.1	477.2	7.22	30.4	99.28	16.2	62,700	135,575	912.1

Note: 86-per cent fixed carbon in coke. Reduction of Mn and P by solid carbon not taken into account.

TABLE VI
"D" Furnace

Period	Total coke consumed, tons per day	Coke burnt at tuyeres, tons per day	Coke for reduction of Si, tons per day	Coke for alloying iron, tons per day	Solution losses, tons per day	Per cent coke consumed above tuyeres, tons per day	Top gas production		Sensible heat of top gas Btu per ton x 1000
							Cfm	Cu ft per ton	
Nov. 21–27, 1958	982.8	718.2	19.9	64.9	179.8	18.3	93,878	92,667	861.1
Nov. 28–Dec. 4	1320.4	864.6	15.5	84.2	356.1	27.0	113,926	88,623	583.4
Dec. 5–11	1299.5	866.4	12.2	82.2	338.7	26.1	114,488	90,916	597.1
Dec. 12–18	1309.2	869.5	15.1	81.9	342.7	26.2	113,872	91,059	690.3
Dec. 19–25	1117.5	873.8	13.8	69.9	160.0	14.3	113,872	107,281	714.5
Dec. 26–Jan. 1, 1959	1281.7	864.5	22.6	87.8	306.8	23.9	112,056	81,921	488.8
Jan. 2–8	1301.2	866.4	18.5	94.0	322.3	24.8	111,226	77,231	478.0
Jan. 9–15	1292.7	863.3	17.8	93.6	318.0	24.6	110,488	77,682	513.4
Jan. 16–22	1307.0	862.7	18.9	94.8	330.6	25.3	111,456	77,418	510.5
Jan. 23–29	1316.7	863.9	18.5	97.2	337.1	25.6	111,456	74,659	462.3
Jan. 30–Feb. 5	1329.5	861.7	17.8	96.7	353.3	26.6	109,902	73,691	455.6
Feb. 6–12	1376.0	896.4	19.4	100.8	359.4	26.1	114,031	74,196	413.8
Feb. 13–19	1390.4	911.0	18.6	102.0	358.8	25.8	116,214	74,508	353.7
Feb. 20–26	1423.6	919.7	18.8	102.4	382.7	26.9	117,070	74,910	419.0
Feb. 27–Mar. 5	1360.8	908.4	18.7	100.4	333.3	24.5	118,056	75,698	444.0

TABLE VII

Period	Sinter, per cent	Ore, per cent	Pellets, per cent	Fe in burden, per cent	Temperature of wind, F	Tons iron per day per cu ft of furnace	Lb coke per ton iron	Cu ft top gas per ton iron	Cu ft top gas per min per sq ft bosh	Btu in top gas per ton iron x 1000
"B" furnace										
Feb. 21–27, 1958	80.0	20.0	...	51.69	1202	0.0446	1358	89,660	154.5	645.2
Feb. 28–Mar. 6	88.6	11.4	...	52.30	1224	0.0469	1314	83,600	151.8	630.9
Mar. 7–13	92.1	7.9	...	53.18	1249	0.0499	1269	77,875	150.9	567.3
Mar. 14–20	100.0	...	...	53.09	1258	0.0503	1246	78,800	153.6	596.2
Mar. 21–27	100.0	...	...	53.11	1310	0.0517	1225	76,630	153.9	573.8
"D" furnace										
Jan. 16–22, 1959	70.0	...	30.0	55.41	1450	0.0450	1282	77,418	147.7	510.5
Jan. 23–29	70.0	...	30.0	55.86	1450	0.0462	1260	74,659	147.7	462.3
Jan. 30–Feb. 5	70.0	...	30.0	55.32	1450	0.0459	1279	73,691	145.6	455.6
Feb. 6–12	65.7	0.7	33.6	56.36	1450	0.0479	1270	74,196	151.0	413.8
Feb. 20–26	67.9	...	32.1	55.38	1453	0.0486	1293	74,910	155.1	419.0
Feb. 27–Mar. 5	67.9	2.1	30.0	54.81	1450	0.0477	1260	75,698	156.4	444.0

creased with the increased use of sinter in the burden, in spite of the higher blast temperatures that were employed with the high sinter burdens. No explanation for this phenomenon is offered.

SINTER-PELLETS PRACTICE

As mentioned in the introduction, in addition to sintering, pelletizing is a common method employed for burden preparation.

After the "B" furnace trial, the calcite sinter was charged to "C" and then to "D" furnace. Since, in both cases, this caused the production rates of the furnaces to increase beyond the capacity of the sinter plant to completely supply any of these furnaces with self-fluxing sinter, pellets were added to the charge to make up the difference. This provided some opportunity of comparing the self-fluxing sinter practice with a mixed sinter-pellets practice.

The type of pellets used was not self-fluxing and they were rather nonuniform in size (mean size 0.5 in., max. 2 in.), but they had a high iron content (62 to 67 per cent Fe) which tended to offset the composition and size disadvantages.

The largest furnace, Figure 10, was selected for comparing the 100 per cent sinter with the sinter-pellets practice. As the stone was gradually removed, the bases in the sinter had to be increased so as to provide the flux requirements of the pellets. In this case the sinter was overfluxed and contained the flux required by the whole burden including the pellets.

In order to compare the efficiencies of different prac-

Figure 11 — This is a comparison of "B" (left) and "D" (right) furnace burden makeups.

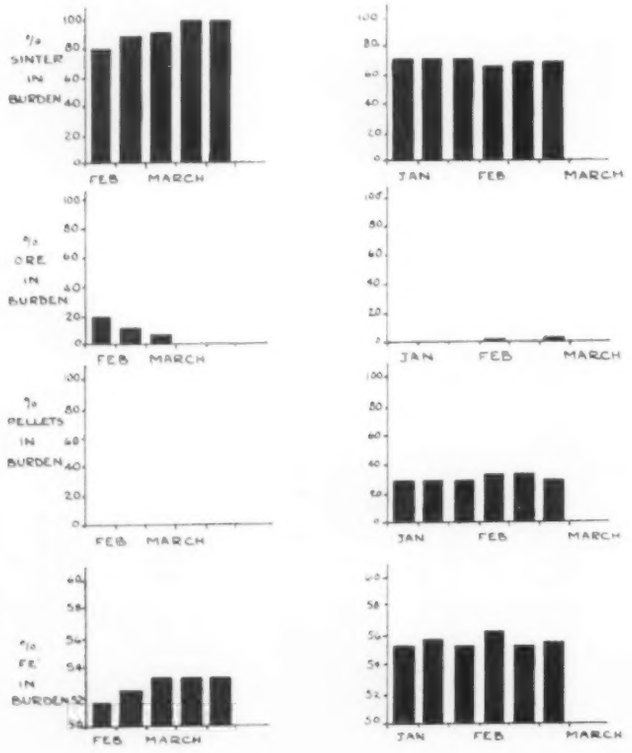
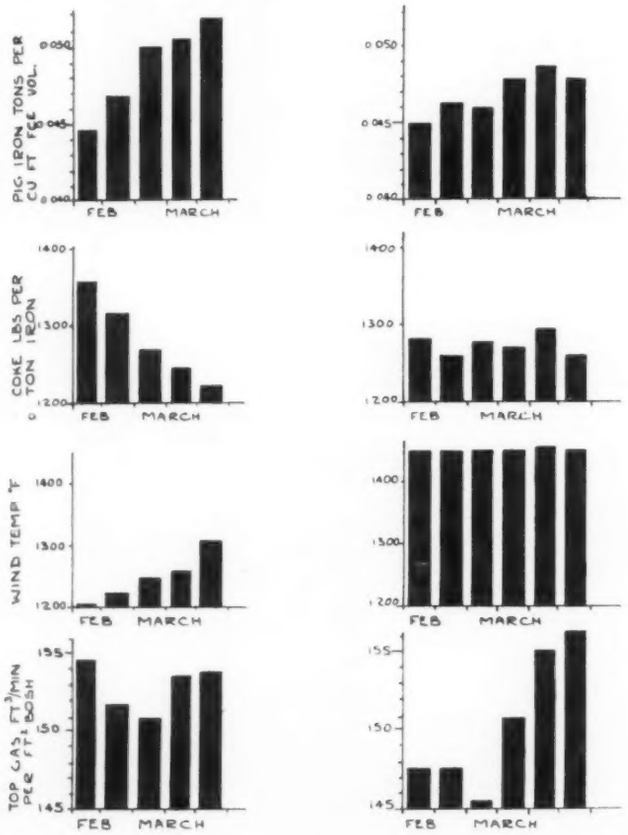


Figure 12 — Comparative production data for "B" (left) and "D" (right) furnaces.



tices an attempt was made to evaluate the per cent coke consumed above the tuyeres (after having accounted for the carbon dissolved in the iron and used for the reduction of silicon), the total gas flow through the furnace per unit of time, the gas produced per ton of iron and its sensible heat, Tables V and VI. The per cent coke burnt at the tuyeres, the solution losses and the per cent coke consumed at the tuyeres, as listed in Tables V and VI, may be used as qualitative guides only since the moisture of wind could not be determined.

The last two parameters in Tables V and VI are of interest since they may be used as an index of the efficiency of the chemical interaction and of the heat exchange between gases and solids in the furnace. The lower the gas production per unit of iron and the lower its sensible heat, the higher the efficiency of the process under similar conditions. This gradual increase in efficiency with increasing per cent sinter in the burden may be attributed to a more uniform and consistent over-all permeability of the stack.

The best comparison is given by operations under relatively similar conditions and particularly when the detrimental effect of carbonates and open hearth slag on the furnace performance was absent.

Table VII and Figures 11, 12, 13 and 14 show the results obtained for both practices with the furnaces on a burden consisting of iron bearing material and coke only. The very small amount of stone used on "D" furnace (5 to 45 lb per ton) may be neglected.

SUMMARY

There are a number of possible reasons which may be suggested for the superior production rates obtained by the use of self-fluxing sinter. It was observed that the weight of iron (in the form of iron oxide in the sinter) could be increased by an amount slightly in excess of the weight of carbon dioxide (in the form of magnesium and calcium carbonate in the flux) removed from the sinter during the sintering process. See Figure 9. The reason that this was possible is not fully understood and will require further study. The replacement of CO_2 by Fe in the charge, however, readily explains the decrease in coke rate that occurred, as more iron was present in the charge while the weight of coke remained the same.

The reason for the increase in production rate is not quite as evident but may be due partly to the fact that with greater concentrations of iron oxides in the furnace greater surface areas of iron oxide are exposed to the reducing gas at any given time and in any given position in the furnace, and although the rate of reduction of the iron oxides may not have changed, the amount of iron produced in a given time will be increased. The increase in production may also be due to the decrease and eventual elimination of the carbon dioxide present in the charge. The release of carbon dioxide within the furnace during the calcination of the fluxes may tend to retard the reduction of iron oxide in the areas in which this carbon dioxide is momentarily present. As the carbon dioxide content of the charge is decreased, the reduction of the oxides may proceed at a steadier and perhaps faster rate in that part of the furnace where calcination of the flux would normally take place.

Another possibility for the increased production is that a more uniform distribution of the rising gases across any plane in the furnace may have been obtained with the high sinter burden since fewer fines were present (as indicated by the reduced quantity of the flue

Figure 13 — Comparison of "B" (left) and "D" (right) furnace gas data.

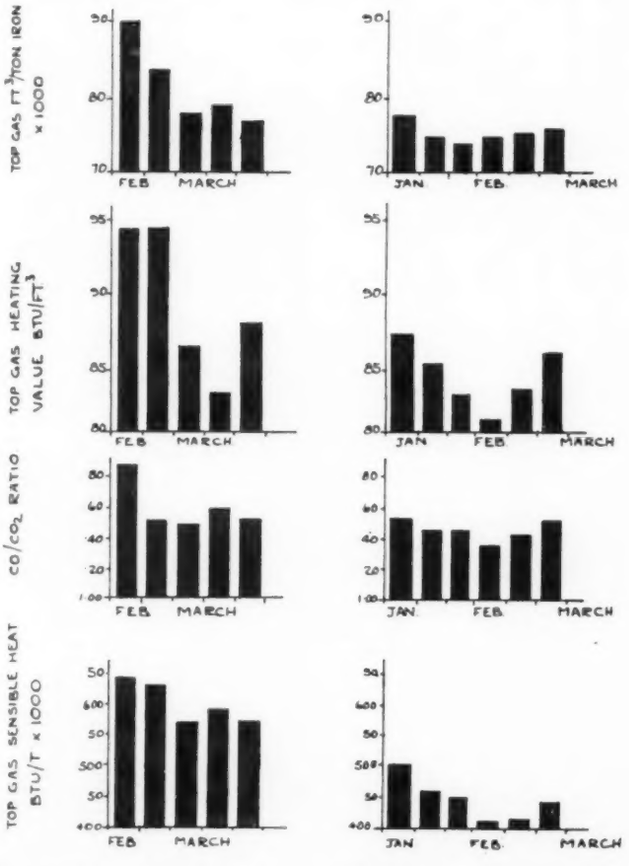
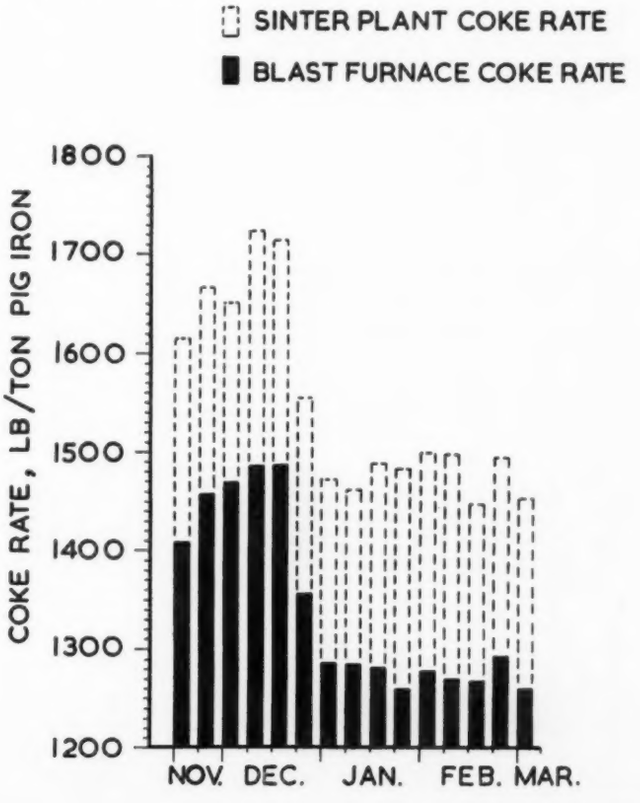


Figure 14 — "D" furnace coke rate data.



dust present in the top gas) to resist the flow of the gases in those spaces where the fines may have segregated. A uniform gas distribution favors increased production because a greater proportion of the burden is exposed to the hot, rising gases at any given time, thus improving the transfer of heat from the gases to the solids and providing more furnace volume active in the reduction of the iron oxides. Such a uniform permeability of the burden was, probably, the reason that higher burden ratios (and, therefore, greater concentrations of iron oxides in the charge) could be used.

As no means are yet available for determining in advance the best operating conditions for any given charge, it is reasonable to assume that the performance of the furnace throughout the trial was not necessarily the optimum that could have been obtained with the present facilities. The operators must necessarily use the trial and error method, aided by experience, in approaching optimum conditions, the optimum being approached cautiously and perhaps never reached, because of the fear of overshooting which could lead to serious disturbances in the working of the furnace. A quantitative means of balancing the burden ratio and composition of the raw materials with the operating variables, i.e., blast temperature, moisture and volume, to obtain the desired metal composition and maximum output would be highly desirable.

As a conclusion to this report the opinion of J. E. Greenawalt (6), expressed in 1938, is quoted:

"The writer believes that in the future the sintering plant will attain a position of much greater importance as an adjunct to the blast furnace and that before long all the fines from ores will be converted into self-fluxing sinter. In the still distant future, he can visualize the sintering of all ores preparatory to treatment in the blast furnace, so that only coke and sinter will be fed into the furnace. The role of prophet is a precarious one, but the prediction can be safely made that the first blast furnace superintendent to use 100 per cent of self-fluxing sinter properly made, so as to be completely free of iron silicates, will have a most pleasant surprise awaiting him not only with reference to the greatly reduced coke consumption but also in regard to increased capacity of the blast furnace and the great uniformity of the furnace operation."

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TABLE VIII
"B" Furnace Charge

Period	Dolomite sinter, per cent	Calcite sinter, per cent	Bonnie ore, per cent	Hickory ore, per cent	Labrador ore, per cent	Keene ore, per cent	Screenings,* per cent	Weight, lb per charge: Scale (71 per cent Fe)	Remelt (93 per cent Fe)	Pig cast material (90 per cent Fe)	Fines** (52 per cent Fe)	Coke	Ore	Stone	Open hearth slag (19 per cent Fe)
Nov. 1–7	60.0	...	30.0	...	10.0	...	...	...	...	114	...	12,366	26,171	4843	1200
Nov. 8–14	60.0	...	29.0	5.8	5.2	...	...	...	...	143	...	12,463	25,600	4571	1200
Nov. 15–21	60.0	...	25.0	15.0	...	...	...	...	...	...	...	12,155	25,657	3629	1200
Nov. 22–28	60.0	...	25.0	15.0	...	...	...	286	...	71	...	12,079	27,257	2729	1200
Nov. 29–Dec. 5	60.0	...	25.0	15.0	...	...	...	214	...	143	...	12,121	27,600	3500	1200
Dec. 6–12	47.1	14.3	23.6	15.0	...	...	...	...	214	71	...	12,331	27,000	3600	1200
Dec. 13–19	18.6	54.3	12.1	15.0	...	...	...	...	286	214	...	12,175	27,114	1843	1200
Dec. 20–26	30.0	50.0	5.0	10.0	...	5.0	...	...	357	...	...	11,997	28,143	1214	1200
Dec. 27–Jan. 2	30.0	50.0	...	...	...	20.0	...	...	357	143	...	11,997	29,114	2000	514
Jan. 3–9	30.0	50.0	...	...	...	20.0	...	...	285	214	...	11,997	30,086	986	...
Jan. 10–16	30.0	50.0	...	...	...	20.0	...	...	500	...	...	12,044	31,200	643	86
Jan. 17–23	30.0	50.0	...	...	...	20.0	...	...	286	214	...	12,030	31,543	1000	29
Jan. 24–30	27.1	52.9	...	...	...	20.0	...	...	357	143	...	12,033	31,600	1071	...
Jan. 31–Feb. 6	20.0	60.0	...	...	...	20.0	...	...	286	214	...	12,001	31,600	629	...
Feb. 7–13	12.1	67.9	...	...	...	20.0	...	...	357	143	...	11,998	31,714	457	200
Feb. 14–20	2.9	77.1	...	...	...	20.0	...	...	357	143	...	11,997	32,086	57	314
Feb. 21–27	...	80.0	1.5	...	...	18.5	...	...	357	71	...	12,170	32,400	...	...
Feb. 28–Mar. 6	22.9	65.7	10.0	...	...	1.4	...	...	500	...	...	12,022	32,800	...	...
Mar. 7–13	32.1	60.0	7.9	...	...	...	...	...	500	...	...	11,998	33,000	...	...
Mar. 14–20	37.1	62.9	...	...	...	...	...	...	500	...	...	12,044	33,857	...	...
Mar. 21–27	45.7	54.3	...	...	...	...	...	...	500	...	...	12,001	34,200	...	...
Mar. 28–Apr. 3	21.2	58.1	5.3	...	...	15.4	...	...	500	...	...	12,194	32,771	843	...
Apr. 4–10	...	4.3	41.4	7.1	...	35.7	11.5	...	500	...	...	12,088	25,086	7257	1100
Apr. 11–17	...	...	40.0	8.3	...	24.6	27.1	71	286	143	143	12,000	23,400	7514	1200

* Screenings—oversize from sinter plant. ** Fines—recovered iron from open hearth slag.

TABLE IX
"D" Furnace Charge

Period	Calcite sinter, per cent	Keene ore, per cent	Labrador ore, per cent	Hilton pellets, per cent	Aurora pellets, per cent	Volunteer ore, per cent	Weight, lb per charge							
							Scale (71.65 per cent Fe)	Remelt (93.0 per cent Fe)	Pig cast material (90.0 per cent Fe)	Fines (52.22 per cent Fe)	Coke	Ore	Stone	Open hearth slag (19.40 per cent Fe)
Nov. 21–27, 1958	64.3	28.6	5.0	2.1	...	...	...	...	...	...	22,300	57,129	4829	...
Nov. 28–Dec. 4	65.0	20.0	5.0	10.0	...	...	...	...	...	...	22,963	56,743	5100	...
Dec. 5–11	60.7	13.6	5.0	15.0	5.7	...	...	...	...	...	23,000	55,200	4957	429
Dec. 12–18	73.6	...	5.0	15.0	6.4	...	...	...	...	...	22,968	55,971	429	571
Dec. 19–25	70.0	...	5.0	2.1	22.9	...	...	...	...	...	22,811	56,957	1216	...
Dec. 26–Jan. 1, 1959	70.0	...	5.0	12.9	12.1	...	...	...	...	...	23,093	58,671	1329	...
Jan. 2–8	66.4	...	3.6	18.6	11.4	...	...	...	...	...	23,029	61,200	1500	...
Jan. 9–15	67.1	...	...	20.0	12.9	...	...	...	...	...	22,880	61,286	1114	...
Jan. 16–22	70.0	...	...	20.0	10.0	...	...	...	...	...	23,133	63,000	...	...
Jan. 23–29	70.0	...	...	20.0	10.0	...	...	...	...	...	23,100	63,000	257	...
Jan. 30–Feb. 5	70.0	...	...	25.0	5.0	...	...	...	...	...	23,361	63,000	171	...
Feb. 6–12	65.7	0.7	...	20.7	12.9	...	...	...	...	...	23,030	63,000	757	...
Feb. 13–19	61.4	3.6	...	15.0	20.0	...	...	...	...	...	23,057	63,000	2357	...
Feb. 20–26	67.9	...	...	19.2	12.9	...	...	...	...	...	23,608	63,000	86	...
Feb. 27–Mar. 5	67.9	2.1	...	15.0	15.0	...	...	...	...	...	22,948	63,000	114	...

TABLE X
"B" Furnace Operating Data

Period	Output, net tons per day	Coke rate, lb per ton	Burden ratio	Blast volume, cfm	Blast temperature, F	Blast pressure, psi	Delay time, min per day	Slag volume, lb per ton	Flue dust, lb per ton	CO/CO_2	Top gas temperature, F
Nov. 1–7	804	1613	2.12	45,000	1293	16.3	36	1183	75	2.10	440
Nov. 8–14	790	1675	2.05	45,000	1241	16.1	27	1162	76	2.11	463
Nov. 15–21	761	1674	2.11	44,953	1194	16.3	33	1139	101	2.41	485
Nov. 22–28	804	1588	2.26	44,841	1200	17.2	31	1081	85	2.09	425
Nov. 29–Dec. 5	780	1577	2.28	43,982	1228	17.1	37	1098	82	1.96	424
Dec. 6–12	784	1610	2.19	43,892	1242	16.8	28	1199	104	2.45	450
Dec. 13–19	739	1647	2.23	44,375	1141	16.6	31	1113	87	2.71	503
Dec. 20–26	704	1587	2.35	43,294	1155	16.9	174	1108	85	2.28	469
Dec. 27–Jan. 2	818	1489	2.43	42,764	1146	16.4	39	1090	52	2.21	417
Jan. 3–9	837	1441	2.51	41,000	1112	15.2	37	1022	43	1.98	400
Jan. 10–16	833	1384	2.59	41,000	1199	15.2	107	974	41	1.84	376
Jan. 17–23	879	1386	2.62	41,000	1232	15.7	27	986	34	1.84	380
Jan. 24–30	895	1373	2.63	41,000	1290	16.2	35	971	34	1.77	360
Jan. 31–Feb. 6	881	1360	2.63	41,000	1257	16.3	26	898	40	2.02	387
Feb. 7–13	877	1397	2.64	41,000	1214	16.6	35	946	34	1.94	387
Feb. 14–20	919	1346	2.68	41,220	1251	17.3	30	997	44	1.86	352
Feb. 21–27	926	1358	2.66	42,000	1202	17.4	26	985	32	1.87	369
Feb. 28–Mar. 6	974	1314	2.73	42,000	1224	16.8	29	993	31	1.53	387
Mar. 7–13	1036	1269	2.75	42,000	1249	15.8	33	939	29	1.49	375
Mar. 14–20	1043	1246	2.81	42,857	1258	16.2	32	992	29	1.60	388
Mar. 21–27	1073	1225	2.85	43,000	1310	16.4	34	954	28	1.53	384
Mar. 28–Apr. 3	961	1341	2.69	42,530	1300	16.3	33	943	33	1.63	342
Apr. 4–10	686	1761	2.10	42,720	1242	15.4	48	1147	64	1.94	354
Apr. 11–17	653	1881	1.95	43,815	1182	15.3	28	1195	69	1.92	345

TABLE XI
"D" Furnace Operating Data

Period	Output, net tons per day	Coke rate, lb per ton	Burden ratio	Blast volume, cfm	Blast temperature, F	Blast pressure, psi	Delay time, min per day	Slag volume, lb per ton	Flue dust, lb per ton	CO/CO_2	Top gas temperature, F
Nov. 21–27, 1958	1395	1409	2.56	67,616	1352	15.9	63	973	30	1.72	442
Nov. 28–Dec. 4	1810	1459	2.53	79,607	1466	16.7	32	968	22	1.59	420
Dec. 5–11	1768	1470	2.40	80,000	1500	17.4	36	978	25	1.70	422
Dec. 12–18	1762	1486	2.44	80,000	1474	19.0	31	959	28	1.85	475
Dec. 19–25	1503	1487	2.50	80,000	1450	18.3	24	907	21	1.76	435
Dec. 26–Jan. 1, 1959	1889	1357	2.54	80,000	1450	18.6	59	859	20	1.55	397
Jan. 2–8	2022	1287	2.66	80,000	1450	19.0	36	755	27	1.45	433
Jan. 9–15	2012	1285	2.68	80,000	1450	20.0	41	790	35	1.44	421
Jan. 16–22	2039	1282	2.72	80,000	1450	19.4	42	797	28	1.53	431
Jan. 23–29	2090	1260	2.73	80,000	1450	18.9	40	779	27	1.46	409
Jan. 30–Feb. 5	2079	1279	2.70	80,133	1450	19.8	46	754	26	1.47	402
Feb. 6–12	2167	1270	2.74	82,422	1450	20.1	30	793	27	1.35	373
Feb. 13–19	2193	1268	2.73	84,000	1450	19.5	34	806	41	1.29	341
Feb. 20–26	2202	1293	2.67	84,619	1453	19.8	31	796	30	1.42	375
Feb. 27–Mar. 5	2160	1260	2.75	85,030	1450	19.4	55	797	32	1.53	390

TABLE XII
Analysis of "B" Furnace Slag and Hot Metal

Period	Blast furnace slag							Hot metal			
	SiO_2, per cent	Al_2O_3, per cent	CaO, per cent	MgO, per cent	S, per cent	Basicity ratio	Slag temperature	S, per cent	Si, per cent	Mn, per cent	S in slag / S in iron
Nov. 1–7	36.00	9.05	39.45	12.00	1.61	1.14	...	0.032	0.87	1.50	50.31
Nov. 8–14	35.46	10.26	38.80	12.46	1.56	1.12	...	0.029	1.04	1.44	53.79
Nov. 15–21	35.52	10.24	37.75	13.20	1.72	1.11	...	0.022	1.08	1.44	78.18
Nov. 22–28	37.02	11.11	35.65	12.70	1.63	1.00	...	0.044	1.10	1.30	37.05
Nov. 29–Dec. 5	37.92	9.64	35.05	14.30	1.56	1.04	...	0.041	1.03	1.29	38.05
Dec. 6–12	36.12	10.06	38.05	12.54	1.63	1.11	...	0.032	0.99	1.31	50.94
Dec. 13–19	36.10	10.02	37.70	12.10	1.56	1.07	...	0.023	1.06	1.43	67.77
Dec. 20–26	36.39	9.33	38.62	12.08	1.59	1.09	...	0.033	1.14	1.23	48.29
Dec. 27–Jan. 2	36.39	8.61	38.37	13.49	1.78	1.15	...	0.033	1.13	0.73	54.12
Jan. 3–9	36.97	8.46	36.65	14.48	1.69	1.12	...	0.035	1.14	0.51	48.45
Jan. 10–16	37.90	8.07	36.90	14.09	1.97	1.12	...	0.048	1.18	0.53	40.96
Jan. 17–23	37.30	9.86	36.42	13.74	1.63	1.06	...	0.043	1.09	0.47	38.00
Jan. 24–30	36.02	11.13	37.16	13.06	1.73	1.07	2805	0.041	0.98	0.29	42.10
Jan. 31–Feb. 6	37.07	10.09	36.26	13.32	1.62	1.04	2799	0.043	1.12	0.32	37.70
Feb. 7–13	37.06	10.70	36.66	12.68	1.48	1.04	2777	0.037	1.07	0.39	40.07
Feb. 14–20	36.38	9.82	38.28	12.94	1.65	1.12	2807	0.034	0.99	0.47	48.46
Feb. 21–27	37.14	10.15	37.80	11.60	1.69	1.04	2782	0.037	1.09	0.44	45.62
Feb. 28–Mar. 6	38.83	11.48	35.87	13.70	1.76	1.05	2787	0.032	1.00	0.62	54.86
Mar. 7–13	35.88	11.91	35.60	13.50	1.70	1.03	2789	0.040	0.93	0.58	42.46
Mar. 14–20	37.44	10.49	35.83	13.08	1.68	1.02	2802	0.038	1.12	0.60	44.31
Mar. 21–27	35.58	12.47	35.60	13.33	1.43	1.02	2815	0.036	0.92	0.51	39.72
Mar. 28–Apr. 3	36.40	11.21	37.85	11.84	1.53	1.04	2828	0.039	0.99	0.63	39.23
Apr. 4–10	33.90	9.10	40.80	12.80	1.74	1.25	2777	0.064	1.12	0.92	271.9
Apr. 11–17	35.60	9.40	41.44	10.08	1.78	1.14	2815	0.031	1.11	1.25	57.42

TABLE XIII
Analysis of "D" Blast Furnace Slag and Hot Metal

Period	Blast furnace slag						Hot metal			
	SiO_2, per cent	Al_2O_3, per cent	CaO, per cent	MgO, per cent	S, per cent	Basicity ratio	S, per cent	Si, per cent	Mn, per cent	S in slag / S in iron
Nov. 21–27, 1958	37.20	7.92	39.80	12.10	1.68	1.15	0.049	1.43	0.84	34.29
Nov. 28–Dec. 4	...	...	...	...	...	...	0.047	0.86	0.74	...
Dec. 5–11	38.00	7.52	44.40	10.40	1.61	1.12	0.030	0.69	0.79	57.00
Dec. 12–18	36.90	7.16	42.70	9.00	1.74	1.17	0.028	0.86	0.78	58.57
Dec. 19–25	37.10	9.46	41.00	8.20	1.72	1.06	0.054	0.92	0.67	32.72
Dec. 26–Jan. 1, 1959	37.60	8.28	40.50	9.90	1.90	1.10	0.033	1.20	0.73	56.67
Jan. 2–8	37.36	8.08	41.15	9.72	1.95	1.12	0.051	0.92	0.60	36.27
Jan. 9–15	36.66	8.58	40.20	11.00	1.98	1.13	0.025	0.89	0.39	77.20
Jan. 16–22	37.76	7.76	41.00	9.70	1.99	1.11	0.039	0.93	0.35	53.33
Jan. 23–29	36.32	7.68	41.00	11.50	1.80	1.19	0.053	0.89	0.35	33.96
Jan. 30–Feb. 5	35.70	7.98	43.20	10.00	1.67	1.22	0.032	0.86	0.38	55.62
Feb. 6–12	34.70	8.34	41.40	12.30	1.69	1.25	0.040	0.90	0.35	43.50
Feb. 13–19	36.00	9.14	42.60	9.30	1.56	1.15	0.038	0.85	0.34	40.26
Feb. 20–26	35.20	9.28	42.10	9.80	1.53	1.17	0.033	0.85	0.34	49.70
Feb. 27–Mar. 5	36.56	8.66	42.80	9.00	1.68	1.15	0.036	0.87	0.38	48.61

TABLE XIV
Analysis of Calcite Sinter Used on "B" Furnace

Period	Fe, per cent	SiO_2, per cent	Al_2O_3, per cent	CaO, per cent	MgO, per cent	FeO, per cent	Basicity ratio	Bulk density, lb per cu ft	Mean particle size, in.	Per cent $-\frac{1}{8}$ in.
Dec. 6–12	...	...	...	...	...	...	...	...	...	...
Dec. 13–19	...	...	...	...	...	...	...	...	...	...
Dec. 20–26	49.50	11.66	1.27	12.85	4.05	...	1.31	...	...	...
Dec. 27–Jan. 2	49.80	11.43	1.30	11.70	3.85	10.47	1.22	...	...	...
Jan. 3–9	51.32	10.22	1.08	11.19	4.77	11.78	1.41	...	...	...
Jan. 10–16	51.72	10.16	1.09	11.94	4.63	12.36	1.47	97.4	0.45	...
Jan. 17–23	51.34	9.99	1.29	11.09	4.46	12.54	1.38	101.5	0.42	...
Jan. 24–30	51.44	9.60	1.40	11.52	4.54	12.44	1.46	100.6	0.44	5.1
Jan. 31–Feb. 6	51.23	9.79	1.46	11.23	4.36	12.85	1.39	103.9	0.45	5.5
Feb. 7–13	50.63	9.76	1.66	11.99	4.77	11.37	1.47	107.2	0.42	8.5
Feb. 14–20	51.04	9.54	1.74	11.47	4.34	11.45	1.40	101.2	0.44	6.6
Feb. 21–27	51.23	9.98	1.42	11.12	4.60	10.50	1.38	101.2	0.60	6.6
Feb. 28–Mar. 6	52.09	8.77	1.66	11.61	4.34	12.03	1.53	106.2	0.43	9.4
Mar. 7–13	52.75	8.86	1.98	10.03	3.91	11.48	1.29	101.7	0.46	7.8
Mar. 14–20	52.78	9.44	1.24	10.26	4.03	12.30	1.34	103.5	0.40	9.3
Mar. 21–27	52.53	8.97	2.17	9.66	3.77	12.50	1.21	101.9	0.52	5.9
Mar. 28–Apr. 3	52.05	8.65	1.96	10.68	4.11	10.75	1.39	105.8	0.42	12.7

TABLE XV
Analysis of Calcite Sinter Used on "D" Furnace

Period	Fe, per cent	SiO_2, per cent	Al_2O_3, per cent	CaO, per cent	MgO, per cent	FeO, per cent	Basicity ratio
Nov. 21–27, 1958	51.62	11.49	0.86	10.89	3.19	12.95	1.14
Nov. 28–Dec. 4	51.44	11.19	0.89	11.77	3.31	11.83	1.25
Dec. 5–11	49.86	10.56	1.12	13.42	3.75	10.62	1.47
Dec. 12–18	50.44	10.36	1.14	12.70	3.69	11.01	1.43
Dec. 19–25	50.57	10.19	1.09	12.07	3.54	10.46	1.38
Dec. 26–Jan. 1, 1959	51.05	9.52	1.17	12.59	3.65	10.84	1.52
Jan. 2–8	52.26	9.36	1.29	10.82	3.57	11.48	1.35
Jan. 9–15	51.57	9.41	1.17	12.16	3.65	10.55	1.49
Jan. 16–22	51.14	9.78	1.19	10.61	5.24	9.44	1.44
Jan. 23–29	51.78	9.14	1.09	10.80	4.82	9.54	1.53
Jan. 30–Feb. 5	50.60	9.22	1.33	12.48	4.64	10.63	1.62
Feb. 6–12	51.97	9.55	1.32	10.37	4.35	10.30	1.56
Feb. 13–19	50.46	9.04	1.33	12.75	3.97	9.88	1.61
Feb. 20–26	50.84	8.84	1.18	12.10	4.81	11.82	1.69
Feb. 27–Mar. 5	50.70	8.54	1.25	13.18	4.14	10.54	1.77

TABLE XVI
Flue Dust Analysis

Period	Fe, per cent	Mn, per cent	SiO_2, per cent	Al_2O_3, per cent	CaO, per cent	MgO, per cent	C, per cent	Basicity, ratio
Nov. 1–7	...	...	...	...	...	...	...	...
Nov. 8–14	...	...	...	...	...	...	...	...
Nov. 15–21	44.00	...	8.60	...	...	...	18.90	...
Nov. 22–28	43.00	...	8.40	...	...	...	18.80	...
Nov. 29–Dec. 5	48.40	...	7.76	...	...	...	17.70	...
Dec. 6–12	44.40	...	7.20	...	...	...	23.00	...
Dec. 13–19	39.20	0.80	9.60	3.88	3.00	3.47	23.40	0.48
Dec. 20–26	30.00	...	10.00	...	...	...	29.6	...
Dec. 27–Jan. 2	37.50	...	8.90	...	...	...	25.0	...
Jan. 3–9	25.00	...	11.52	...	...	...	36.88	...
Jan. 10–16	26.40	0.20	12.68	2.02	6.00	3.53	36.80	0.65
Jan. 17–23	21.40	...	11.00	...	...	...	45.20	...
Jan. 24–30	24.80	...	9.88	...	...	...	38.00	...
Jan. 31–Feb. 6	21.00	...	8.80	...	...	...	45.10	...
Feb. 7–13	24.10	0.10	12.02	2.28	6.40	3.42	38.50	0.69
Feb. 14–20	25.20	...	9.52	...	...	...	38.64	...
Feb. 21–27	15.30	...	7.84	...	...	...	56.86	...
Feb. 28–Mar. 6	24.40	...	8.56	...	...	...	38.80	...
Mar. 7–13	26.70	0.18	8.44	1.84	6.70	3.27	35.46	0.97
Mar. 14–20	28.40	...	9.20	...	...	...	34.74	...
Mar. 21–27	28.60	...	9.20	...	...	...	35.88	...
Mar. 28–Apr. 3	32.00	...	9.20	...	...	...	22.84	...
Apr. 4–10	40.00	...	11.60	...	...	...	19.76	...
Apr. 11–17	41.00	0.50	10.44	1.83	3.20	1.11	24.60	0.35

TABLE XVII
Calcite Sinter Mix, Per Cent

Period	Dolomite	Calcite	Coke breeze	Bonnie dust mix	Canada dust mix	Scale	Canada	Beacon	Champion
Dec. 6–12	14.6	9.9	7.3	...	9.1	...	21.8	37.0	...
Dec. 13–19	14.9	10.0	5.7	...	9.4	...	25.1	34.9	...
Dec. 20–26	14.2	10.2	6.2	...	10.1	...	24.6	34.7	...
Dec. 27–Jan. 2	15.1	10.3	6.1	...	10.0	...	23.7	34.8	...
Jan. 3–9	15.1	10.4	6.9	...	...	10.00	23.6	34.0	...
Jan. 10–16	14.9	10.9	6.8	...	...	9.60	22.9	34.9	...
Jan. 17–23	14.8	10.6	7.1	...	...	...	19.2	27.4	20.9
Jan. 24–30	15.3	10.3	7.3	...	...	...	...	36.1	31.0
Jan. 31–Feb. 6	15.2	10.4	7.7	...	...	...	...	39.4	27.3
Feb. 7–13	14.8	9.9	7.0	...	...	...	...	43.3	25.0
Feb. 14–20	14.9	10.5	6.4	18.5	...	...	...	27.4	22.3
Feb. 21–27	15.1	10.2	5.7	19.0	...	...	...	31.0	19.0
Feb. 28–Mar. 6	14.0	10.4	6.6	...	...	15.4	53.6	...	...
Mar. 7–13	10.6	10.4	6.7	...	...	10.6	61.7	...	...
Mar. 14–20	11.3	10.4	7.4	...	...	10.8	30.6	29.5	...
Mar. 21–27	10.6	10.1	7.4	...	...	10.7	61.2	...	...
Mar. 28–Apr. 3	10.8	10.3	7.7	...	...	10.4	60.7	...	...

TABLE XVIII
Dolomite Sinter Mix, Per Cent

Period	Dolomite	Coke breeze	Canada dust mix	Scale	Canada	Beacon	Bonnie	Champion
Nov. 1–7	13.7	6.3	...	9.5	32.2	38.3	...	...
Nov. 8–14	14.2	6.4	...	9.9	30.6	38.9	...	...
Nov. 15–21	19.2	4.1	18.9	9.6	15.3	32.9	...	...
Nov. 22–28	17.6	4.8	17.7	9.8	16.1	34.0	...	...
Nov. 29–Dec. 5	18.0	5.9	10.0	10.3	23.4	32.4	...	...
Dec. 6–12	18.4	6.2	9.8	...	27.4	38.2	...	...
Dec. 13–19	18.5	6.5	9.5	...	27.6	37.9	...	...
Dec. 20–26	18.4	6.0	10.0	...	26.7	38.9	...	...
Dec. 27–Jan. 2	18.2	6.1	10.5	...	25.6	39.6	...	...
Jan. 3–9	18.2	6.7	...	9.9	17.7	26.2	...	21.3
Jan. 10–16	18.6	6.6	...	10.3	26.0	38.5	...	...
Jan. 17–23	18.5	7.0	...	10.0	16.5	26.2	...	21.8
Jan. 24–30	18.5	7.6	...	...	...	39.5	...	34.4
Jan. 31–Feb. 6	18.6	7.2	...	...	...	43.7	...	30.5
Feb. 7–13	18.4	7.4	...	...	...	38.3	14.8	21.1
Feb. 14–20	18.0	6.5	...	...	...	35.8	19.6	20.1
Feb. 21–27	16.8	5.8	...	...	...	37.4	20.9	19.1
Feb. 28–Mar. 6	18.4	7.6	...	11.6	62.4	...	...	...
Mar. 7–13	18.4	7.6	...	11.4	62.6	...	...	...
Mar. 14–20	17.6	7.8	...	10.8	31.6	32.2	...	...
Mar. 21–27	17.0	7.2	...	10.7	65.1	...	...	...
Mar. 28–Apr. 3	15.4	8.1	...	10.9	65.6	...	...	...

TABLE XIX
Dolomite Sinter Analysis

Period	Fe, per cent	SiO_2, per cent	Al_2O_3, per cent	CaO, per cent	MgO, per cent	FeO, per cent	Basicity ratio
Nov. 1–7	55.30	11.74	1.39	5.45	3.98	...	0.72
Nov. 8–14	55.00	11.36	1.29	4.60	4.06	14.05	0.76
Nov. 15–21	54.20	10.82	1.19	6.80	4.68	12.94	0.96
Nov. 22–28	53.00	10.82	1.30	8.20	5.59	12.60	1.14
Nov. 29–Dec. 5	53.20	10.64	1.25	7.65	5.14	12.40	1.08
Dec. 6–12	51.60	12.01	1.66	8.10	4.67	12.90	0.93
Dec. 13–19	50.83	11.91	1.69	8.58	5.27	13.26	1.03
Dec. 20–26	51.43	11.96	1.53	7.87	4.78	12.13	0.94
Dec. 27–Jan. 2	...	...	...	...	...	...	...
Jan. 3–9	...	...	...	...	...	...	...
Jan. 10–16	...	...	...	...	...	...	...
Jan. 17–23	...	...	...	...	...	...	...
Jan. 24–30	...	...	...	...	...	...	...
Jan. 31–Feb. 6	...	...	...	...	...	...	...
Feb. 7–13	52.50	10.18	1.35	7.90	4.58	...	1.08
Feb. 14–20	52.70	10.00	1.30	7.80	3.66	...	1.01
Feb. 21–27	52.40	9.88	1.88	8.70	4.38	...	1.11
Feb. 28–Mar. 6	52.50	9.50	1.42	8.60	4.96	...	1.24
Mar. 7–13	54.00	9.04	1.90	7.60	4.67	...	1.12
Mar. 14–20	53.60	10.26	1.38	7.50	5.44	...	1.11
Mar. 21–27	53.80	8.54	2.24	7.50	4.99	...	1.16
Mar. 28–Apr. 3	53.30	9.20	2.51	7.25	4.44	...	1.00

Discussion

PRESENTED BY

J. B. HILL, Assistant to Vice President, Bethlehem Steel Co., Bethlehem, Pa.

CLYDE M. HORAN, General Superintendent, Steel and Coke Plants, The Youngstown Sheet and Tube Co., Indiana Harbor Works, East Chicago, Ind.

J. H. STRASSBURGER, Vice President—Research and Development, National Steel Corp., Pittsburgh, Pa.

R. P. LIGGETT, Chairman, Blast Furnace Committee, Republic Steel Corp., Cleveland, Ohio

J. B. Hill: When the steel industry first realized that sintering is something considerably more than just a salvage operation—and this has not been so many years ago—operators did not appreciate the full possibilities of the effect of sinter quality. In fact, there was no measure of sinter quality at first, and even today we are not sure that we are measuring all the qualities of sinter that may affect blast furnace operation.

However, we have come a long way toward measuring certain qualities of sinter that appear to be obviously critical. It should not necessarily be inferred that two sinters with the same physical qualities will give the same results in different blast furnaces; there are other operating conditions at each blast furnace plant that can alter to a degree the optimum specifications of the sinter to be used there. To a certain extent, and to our ability to produce, the sinter for a given plant has to be more or less "tailor made" to fit the requirements of that plant if the best blast furnace results are to be obtained. This is especially true in the use of flux-bearing sinter. Also in the case of flux-bearing sinter, it may be that the percentage sinter in the burden may have a large effect on the production and fuel rates of the blast

TABLE XX

Analysis and Operating Data Blast Furnace Coke

Period	Flue temperature, F	Net coking time, hr	Gross coke mean size, in.	Shatter +1½ in., per cent	Tumbler		Porosity, per cent	Blast furnace coke analysis coke used "B" furnace, per cent				
					Stability +1	Hardness +½		Ash	Sulphur	Volume	Nut coke	Reclaimed coke
Nov. 1–7, 1957	2112	24.22	3.01	89.64	51.65	63.14	51.12	10.22	1.26	2.32	...	...
Nov. 8–14	2110	24.00	2.98	89.67	49.69	62.87	51.75	9.98	1.24	2.51	1.32	...
Nov. 15–21	2162	22.74	2.89	88.70	51.03	64.60	50.68	10.26	1.25	2.88	...	...
Nov. 22–28	2218	20.75	2.69	87.15	48.33	61.62	50.91	10.00	1.27	2.89	2.71	...
Nov. 29–Dec. 5	2208	22.02	2.79	87.39	52.99	67.61	50.35	10.74	1.26	3.31	1.21	...
Dec. 6–12	2134	22.79	2.86	87.23	51.83	63.19	50.40	10.68	1.26	3.37	0.76	...
Dec. 13–19	2157	22.79	2.79	88.52	52.78	65.31	49.68	10.61	1.26	3.24	0.80	...
Dec. 20–26	2108	23.39	2.80	89.53	54.15	66.56	48.55	10.79	1.27	2.88	...	...
Dec. 27–Jan. 2, 1958	2096	22.89	2.82	90.37	55.21	67.35	51.30	10.36	1.28	1.38	...	...
Jan. 3–9	2250	19.65	2.76	87.63	52.68	64.40	51.28	10.51	1.28	1.53	...	...
Jan. 10–16	2253	18.60	2.66	87.86	55.20	67.31	50.62	10.55	1.28	1.92	4.60	3.50
Jan. 17–23	2316	18.15	2.52	89.85	54.31	65.99	50.16	10.69	1.27	1.76	12.49	9.36
Jan. 24–30	2352	18.02	2.43	89.46	51.31	64.50	50.92	11.04	1.27	1.74	5.03	11.79
Jan. 31–Feb. 6	2369	17.71	2.44	87.51	52.47	66.95	50.44	11.05	1.25	1.96	16.62	7.99
Feb. 7–13	2424	17.71	2.41	87.47	52.42	67.23	50.01	10.82	1.25	2.35	7.90	5.03
Feb. 14–20	2393	17.71	2.43	88.26	52.41	64.89	50.85	10.81	1.26	2.23	21.73	3.19
Feb. 21–27	2380	17.71	2.42	87.40	53.22	64.33	50.14	10.64	1.25	2.78	15.91	3.27
Feb. 28–Mar. 6	2400	17.71	2.46	89.51	53.26	63.61	50.39	10.66	1.22	2.58	13.06	3.40
Mar. 7–13	2383	17.65	2.32	88.55	52.06	63.19	50.91	10.75	1.26	2.90	22.64	8.43
Mar. 14–20	2418	16.97	2.28	88.06	52.09	64.00	49.90	10.83	1.25	2.74	17.33	2.20
Mar. 21–27	2436	16.36	2.06	89.22	52.03	64.06	50.36	10.72	1.26	2.94	25.05	1.13
Mar. 28–Apr. 3	2464	16.56	2.05	87.91	51.60	62.83	50.38	10.83	1.27	3.27	31.04	...
Apr. 4–10	2485	16.89	2.18	89.05	51.58	63.56	50.88	10.67	1.26	2.51	29.69	...
Apr. 11–17	2465	16.78	2.29	88.79	51.64	61.90	50.60	10.56	1.26	1.81	26.72	...

TABLE XXI

Raw Material Analysis, Per Cent

	Fe	P	Mn	SiO_2	Al_2O_3	CaO	MgO	S	H_2O
Bonnie	53.14	0.065	0.42	8.85	2.05	0.23	0.33	0.008	9.48
Beacon	49.64	0.041	0.30	11.68	0.33	0.18	0.27	0.014	10.30
Canada	50.63	0.061	0.61	8.80	1.80	0.18	0.34	0.027	9.36
Hickory	49.10	0.534	2.23	7.26	2.14	1.77	0.84	0.036	6.56
Keene	53.59	0.053	0.29	8.55	0.35	0.24	0.09	0.031	6.74
Pig cast material	90.0	...	...	...	...	...	...	...	...
Scale	71.0	...	...	...	...	...	...	...	...
Remelt	93.0	...	...	...	...	...	...	...	...
Fines	52.2	...	...	...	...	...	...	...	...
Open hearth slag	19.0	...	...	14.4	3.20	35.8	11.22	...	...
Limestone	...	...	...	0.88	0.48	53.60	1.32	...	...
Dolomite	...	...	...	0.56	0.42	30.01	21.21	...	...
Coke	1.0	...	...	4.14	3.26	1.00	0.36	...	...
Aurora pellets	62.79	0.009	0.20	8.80	0.24	0.15	0.20	0.005	0.35
Hilton pellets	66.21	0.005	0.04	2.49	0.20	0.43	0.93	0.020	0.96

furnace. This is a hot subject of discussion among some blast furnace operators, and only until it is thoroughly investigated can the points of difference be resolved. This particular point may be the explanation of why the 100 per cent sinter burden on the "B" furnace at The Steel Co. of Canada gave almost equal results in percentage gain with the "D" furnace, which was using the same sinter but with the burden enriched with high iron pellets.

I have been asked to comment on the foregoing paper from the point of view of particle size and coke quality.

When the use of a material in a blast furnace—in this case flux-bearing sinter—gives increases of about 50 per cent in production and decreases of about 30 per cent in coke rate, it can be concluded that the material is doing an excellent job. But, as Mr. McMahan has stated the appearance of this sinter has been "severely criticized." There is nothing wrong with such criticism for it acts as a spur to investigation and perhaps to progress.

Let us look at a screen analysis of this sinter:

+1 in.... 7.3 per cent
−1 in. x +½ in....18.9 per cent
−½ in. x +¼ in....49.6 per cent
−¼ in. x +⅛ in....16.2 per cent
−⅛ in....8.0 per cent

Without doubt the criticism that has been leveled at this sinter arises from a casual inspection which indicates predominantly small size as shown by the high percentage of the −½ in. x + ⅛-in. fractions.

It is generally accepted opinion that the less fines a sinter contains, the better it will work in a blast furnace. To those of us who have worked with sinter for a long time, any sinter with only 8 per cent −⅛ in. is good sinter from the standpoint of fines.

Right here would be an excellent place to launch into a discussion of blast furnace stock column permeability, but instead that subject had better be left to the individual to consider.

Apropos to stock column permeability, there is a group of operators in Europe who are judging the merit qualities of sinters by the amount of +1 in. as well as the −⅛-in. sizes contained in the sinter. It is something to be investigated for perhaps it is an indication of how

well the sinter will stand descending the furnace stack without excessive breakage, which may contribute inversely to stock column permeability.

It will be noted that the screen test of this sinter indicates 7.3 per cent +1 in. which may or may not be optimum. There are those that consider this percentage too small. One fact that strengthens this thinking is that only 80,000 cu ft of wind per minute was blown on the "D" furnace which is of 28-ft hearth diam. This raises the question as to whether more than 80,000 cu ft of wind per minute could have been blown, with improvement in tonnage and economies, if the average particle size of the sinter had been larger.

The Steel Co. of Canada has reported their sinter as having a mean particle size of 0.45 in. Without doubt the sintering plant operator has some rough control of this particle size, and we have been informed that at The Steel Co. of Canada there has been an effort made to keep the particle size small, as indicated. The smaller the particle size the more surface is exposed to the reducing action of the gases in the furnace, and presumably more indirect reduction takes place—a desirable condition to attain. Reducing the particle size can be carried too far and then it results in low permeability of the stock column, which in turn limits wind blown and hence, production. Therefore, at each blast furnace plant where the use of sinter is important, optimum sinter particle size as well as other sinter qualities has to be determined and maintained if maximum tonnage and economies are to be attained.

My comments on this paper from the point of view of coke quality will be very brief. Coke analysis is as follows:

Ash	10.60 per cent
Sulphur	1.25 per cent
Volatile matter	2.50 per cent

Iron produced on "D" furnace for the months of January and February, 1959, was as follows:

	Jan. '59	Feb. '59
Si	0.91	0.87
S	0.042	0.035
P	0.059	0.059
Mn	0.43	0.35

In view of the high ash and sulphur content of the coke, The Steel Co. of Canada is to be congratulated on the excellent results they are attaining on their blast furnaces.

Clyde M. Horan: To increase blast furnace production through improved burden preparation has and will continue to offer substantial challenges to every blast furnace operator for many years hence. It is my personal observation that the industry has just begun to prove the technical potentials of blast furnace production through the art of mechanical and chemical beneficiation and upgrading of all raw materials.

The need to establish basic properties of fluxed sinter as a blast furnace burden material has been long overdue. This paper gives an established basis by which future evaluation of both furnace performance and sintering practices may be compared. Whether we, as individuals, wish to take exception to all or any part of what is reported in this paper is of little significance. The author, however, has outlined specific comparative operating practice and performance rather than a theoretical approach to fluxed sinter applications to the blast furnace.

We cannot find fault with Mr. McMahan's operations when he increases production approximately 60 per cent over his previous operations but would offer the following constructive thought for future evaluation. Practice at Stelco has been to add steam to the blast as a measure to enhance furnace throughput and performance without controlled or accurate measurements. We are all familiar with the advantages steam lends to furnace operations without introducing any prolonged dissertation. I would, however, suggest that some consideration be given to operating of a blast furnace at the maximum hot blast while using the steam additions as a direct control for furnace temperature. This should afford an optimum blast temperature, coke burning rate and moisture addition to provide peak operating efficiency on the furnace.

It is apparent from the paper that the furnace was controlled entirely on blast temperature and burden changes.Would it not be better to utilize all of the hot blast temperature and thus control the furnace temperature through measured steam additions? Such a procedure should lend new concepts to a heat balance and furnace performance.

Our own experience at The Youngstown Sheet and Tube Co. with beneficiated burdens to date has been very gratifying. During October, 1958, the No. 3 blast furnace at the Campbell plant operated on a 94.3 per cent beneficiated burden. The burden consisted of 57.6 per cent fluxed sinter (bases/acids ratio = 0.75), 29.3 per cent Erie pellets (screened), and 7.4 per cent heads. This furnace has a 23-ft hearth and, during October, 1958, had a production rate of 1515 net tons per day or 3.65 tons per sq ft of hearth area. This is a 35 per cent increase over previous operations. The coke rate was 1494 lb per ton of metal, which was a 16.7 per cent reduction over previous operation. The wind was 80,000 cfm with a 1042-F hot blast; no moisture was added.

The unique operating practice which is followed on this furnace is the manner in which sinter is charged. All sinter is handled directly to the furnace hot—no cooling. We charge the sinter through automatic weigh hoppers, by-passing our scale car. The advantage gained here was not in hot sinter to the furnace but rather the elimination of water quenching which gave a stronger sinter with less degradation. Our fines (−6 mesh) in sinter averaged below 6.50 per cent since this practice has been adopted. At present, we are operating this furnace on 90 to 100 per cent sinter burden but have no data on furnace performance to offer at this time.

J. H. Strassburger: We agree that the ability to obtain high and uniform permeability of the stock with

TABLE XXII

Sinter	1959, February
Fe, per cent	51.75
FeO, per cent	9.45
SiO_2, per cent	10.65
Al_2O_3, per cent	1.95
CaO, per cent	11.84
MgO, per cent	0.78
Basicity	1.00

TABLE XXIII

	1957, February	1959, February
Iron production—tons per day	1396	2004
Coke rate—lb per ton	1765	1410
Stone rate—lb per ton	850	269
Blast temperature, F	1031	1641
Moisture—grains per cu ft	7.41	20.7
Per cent sinter	...	81.26
Per cent coarse ore	...	13.43
CO/CO_2 ratio	2.25	1.91

properly sized burden material for the optimum in gas-solid contact is the number one factor for improved blast furnace performance. We place reduction of the thermal load as second instead of fourth, inasmuch as each 100 lb of limestone that can be taken out of the burden and calcined in the sinter plant makes possible a saving of about 30 lb of coke per ton of iron with a proportionate increase in iron production at the same driving rate.

In National Steel, our policy has been to improve blast furnace performance by means of the use of a sized burden consisting of about 65 per cent sinter and 35 per cent coarse ore. The sinter should be both strong and self-fluxing with the ability to take high blast heat for fast driving rates. Our experience has indicated that strength should not be sacrificed for self-fluxing properties.

Table XXII shows the sinter analysis as used by Great Lakes Steel Corp. on "D" furnace in February 1959.

Table XXIII shows the effect of sinter and coarse ore on the furnace operation.

It will be noted that in February, 1959, on a beneficiated burden of lime-sinter and coarse ore, "D" furnace produced an average of 2004 tons per day at a coke rate of 1410 lb per ton, as compared with a production of 1396 tons per day at a coke rate of 1765 in 1957. The decreased stone rate, increased blast temperature and increased moisture content in the blast should be noted in February, 1959, practice.

We want to point out that the "D" furnace was enlarged from 28 to 29 ft-6 in. in hearth diam between these two periods. However, the production increased by 29 per cent based on tons per day per sq ft of hearth area, with a reduction in coke of 355 lb per ton or a 20-per cent saving.

It will be noted in Table XXII that the lime sinter had a base-acid ratio $CaO + MgO/SiO_2 + Al_2O_3$ of approximately 1.0.

Table XXIV shows the lime-sinter screen analysis. Every effort is being made to increase the percentage of plus ¼-in. sinter in order to improve the sizing of the burden with better gas-solid contact.

At the Weirton plant, limestone has been used in the sinter mix for over two years. Recently, the percentage of limestone in the sinter mix was increased from 8 to 12 per cent resulting in a better base-acid ratio and a

TABLE XXIV

Size	Per cent
+1 in.	18.6
−1 in. + ¼ in.	65.7
−¼ in.	15.7
Basicity	1.00

TABLE XXV

	1959, January	1959, April
Sinter	8 per cent stone	12 per cent stone
Fe	57.52	55.68
FeO	12.05	11.67
SiO_2	9.36	9.33
Al_2O_3	2.05	2.39
CaO	4.00	6.70
MgO	1.14	1.71
Basicity	0.45	0.72

reduced thermal load on the blast furnace. With the increased limestone content, the sintering practice was also improved with better pelletizing of the sinter mix in the balling drum together with improved ignition resulting in a stronger sinter.

Table XXV compares the sinter analysis for January 1959 with April 1959 with a change from 8 to 12 per cent dolomitic limestone. It will be noted that the base-acid ratio was increased from 0.45 to 0.72.

Table XXVI demonstrates the improvement in furnace practice with the use of an increased amount of relatively strong 12 per cent limestone sinter. It should be noted that the iron production of the four Weirton furnaces is increased by 576 tons per day or about ten per cent with a decrease in coke rate of 113 lb per ton and a drop in stone rate of 200 lb per ton. During the two periods, blast temperatures and moisture additions were about the same.

TABLE XXVI

	1959, January	1959, April
Iron production—tons per day	5844	6320
Coke rate—lb per ton	1604	1491
Stone rate—lb per ton	652	453
Per cent sinter	43.16	64.15
Per cent coarse ore	14.39	23.77
CO/CO_2 ratio	1.93	1.80*

* In April No. 3 blast furnace had a CO/CO_2 ratio of 1.67.

Indicative of improved furnace practice is the decrease in the CO/CO_2 ratio from 1.93 to 1.80 for all four furnaces with recent practice showing ratios in the range of 1.55 to 1.65.

Mr. McMahan made reference in his paper to the use of Osborn's slag diagrams to determine the proper MgO-CaO relationship in self-fluxing sinter. This practice has merit and it has been the policy at National Steel to use Osborn's diagrams for determining the proper slag composition for the desired slag liquidus temperature.

Varying amounts of calcite and dolomite are used in the sinter mix at Great Lakes to obtain the desired base-acid ratio. At Weirton, with the availability of dolomitic limestone fines in the sinter, the base-acid ratio is adjusted by adding dolomite and calcite to the furnace burden. A typical slag diagram for Great Lakes Steel's "D" furnace is shown in Figure 15.

Mr. McMahan suggests that two types of sinter should be produced, one slightly basic with the other slightly acidic in order to control the slag composition. It is our opinion that a single grade of sinter would simplify furnace practice.

The statement is made that a varying blast temperature is used as a means of control. It is our opinion that the maximum possible blast temperature should be used

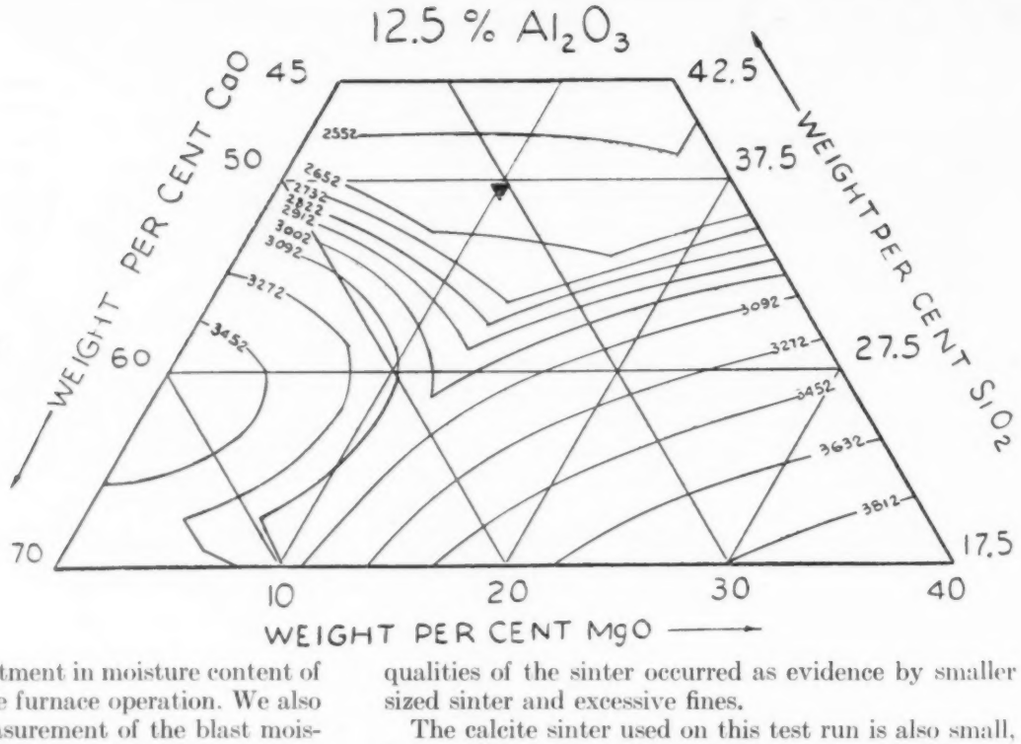


Figure 15 — Typical slag analysis on Great Lakes' "D" furnace consists of 37.1 per cent SiO_2, 11.8 per cent Al_2O_3, 40.2 per cent CaO and 10.4 per cent MgO.

continuously with an adjustment in moisture content of the blast for controlling the furnace operation. We also consider that accurate measurement of the blast moisture is a "must" for proper furnace operation.

We are definitely of the opinion that a strong self-fluxing sinter with all burden materials properly sized, including a strong coke used in conjunction with high blast temperature and moisture additions, are necessary to obtain the optimum in blast furnace productivity and coke rate.

R. P. Liggett: The production and use of high lime-bearing sinter is a very active project at most American blast furnace plants today. A recent poll of the industry showed that the majority of the plants having sintering operations were adding some lime to the sintering mix.

It is certainly of little credit to us that acceptance in the country of this development has taken so long. Lime sinters have been produced in Sweden since 1942. The excellent results from their use were reported by Tigerschiöld and later Danielsson. For some time at the Appleby-Frodingham plant in Scunthorpe, England, high lime sinter has been made by blending low grade lime-bearing and siliceous ores. The remarkable success of this operation was reported by George Elliot.

If any doubt remained concerning the value of lime sinter, it was effectually dissipated by the exchange visits with the Russian steel industry last year. Whether or not invented by them, as they no doubt claim, they have certainly made use of lime sinter for some time and the results have been outstanding.

This paper covers the first extensive work that has been done with self-fluxing sinter on this side of the water. Mr. McMahan has given us some excellent operational data that should clinch the case for self-fluxing sinter.

A distinction is made in the paper between calcite sinter, a truly self-fluxing sinter, and dolomite sinter, a high lime-bearing sinter. The former had a base to acid ratio of 1.30 to 1.40 compared to 1.02 for the latter.

Most of the lime sinter being made in this country today is of the lower basicity as characterized by the dolomite sinter. Whenever higher basicity ratios have been attempted, a marked deterioration in the physical qualities of the sinter occurred as evidence by smaller sized sinter and excessive fines.

The calcite sinter used on this test run is also small, having a mean size of 0.45 in. It was remarkably free from minus ⅛-in. fines. The operating data indicates that the smaller sized sinter is certainly not detrimental to furnace operations as long as most of the minus ⅛-in. material is screened out. It is quite probable, too, that the relative absence of the larger sinter lumps had a beneficial effect on gas distribution, thus contributing to the improved performance of the furnace.

Much has been said about the improved permeability of the blast furnace stock column as a step toward blowing at higher wind rates. It is interesting to note that slightly lower wind rates were blown on Furnace "B" during the 100 per cent sinter period. Increased tonnage was obtained because of the decreased coke rate which, of course, is a very good and economical way of getting it.

Experience indicates that high sinter charges are not conducive to high wind rates in spite of the increased permeability of the charge. The abrupt and extreme rises in top gas temperature which were encountered early in this test run are not uncommon on high sinter burdens and are a deterrent to high blowing rates.

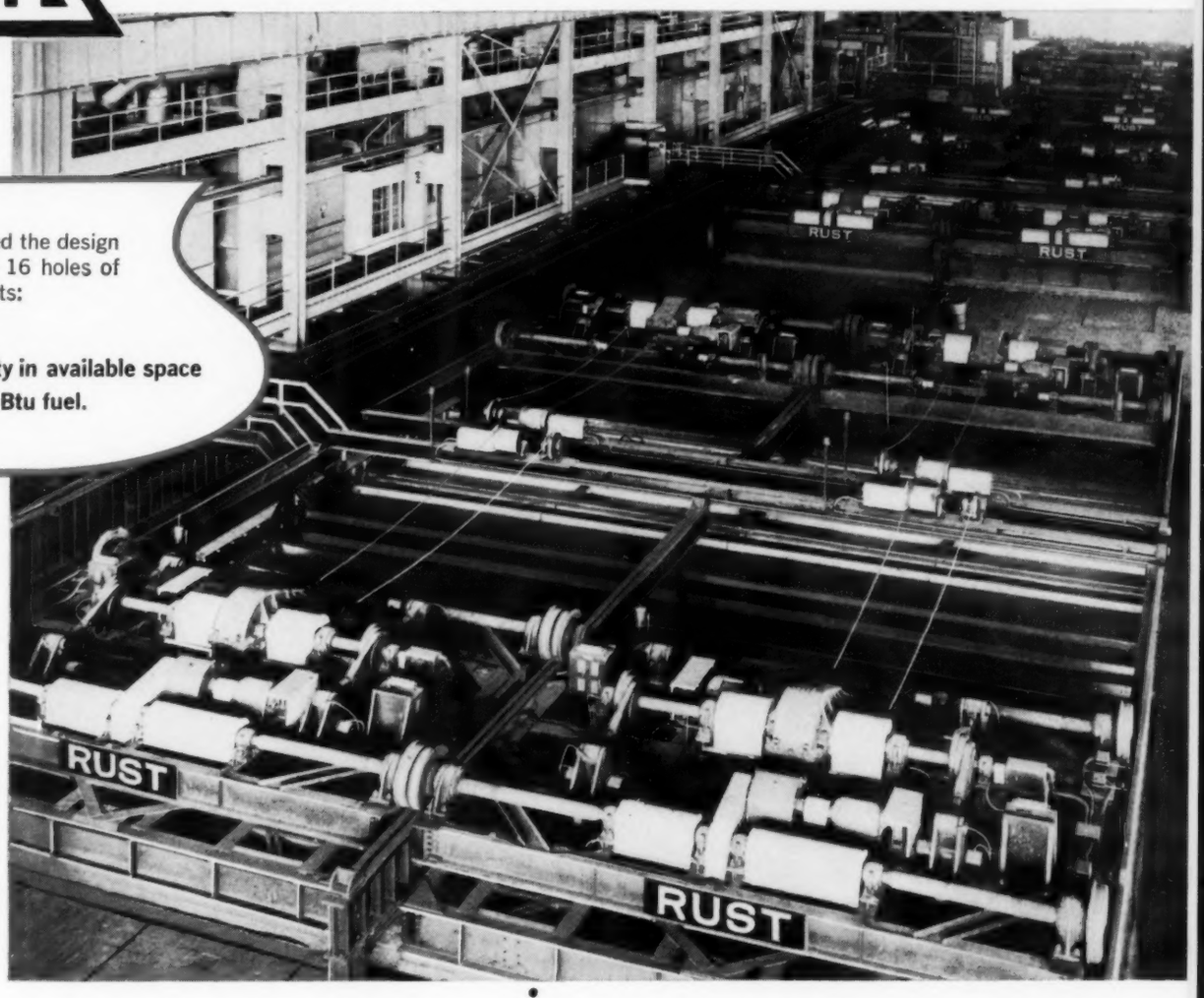
Low FeO content is commonly used as a measure of the reducibility of sinter. Both the dolomite and calcite sinters used on this test showed low FeO content when compared to sinters produced without lime additions. This appears to be one of the benefits which lime additions have made to sinter quality.

Theoretically, we should save in the blast furnace about 30 lb of coke for each 100 lb of raw limestone removed from the charge and for which a calcined agglomerate is substituted. In actual practice, however, it has been indicated that the savings may be somewhat less, but still worth going after.

With the advent of many new and large sintering plants in this country, a fund of information on lime sinters should be available soon. Of particular interest will be a comparison of results between a truly self-fluxing sinter and one of greater strength but somewhat less basicity. ▲

soaking pits

accelerate ingot capacity ... even with low Btu fuel



Three requisites dictated the design requirements of these 16 holes of regenerative soaking pits:

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3. **Utilization of low Btu fuel.**

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Completely modern temperature and combustion controls insure rapid, efficient heating with a high degree of uniformity from top to bottom and complete absence of washing.

Pits are cross-fired and each pit has primary checkers at the base of the downtakes and also secondary checkers at the base of ejector type stacks. The checker system preheats combustion air to approximately 2000°F. Each pit has two induced draft stacks equipped with automatic reversal systems enabling each hole to handle 35,000,000 Btu per hr. input of 106 Btu per cu. ft. mixed coke oven and blast furnace gas. Fuel rate for heating 3½ hr. track time steel is approximately 500,000 Btu per ton and 1,100,000 Btu per ton when heating cold steel.

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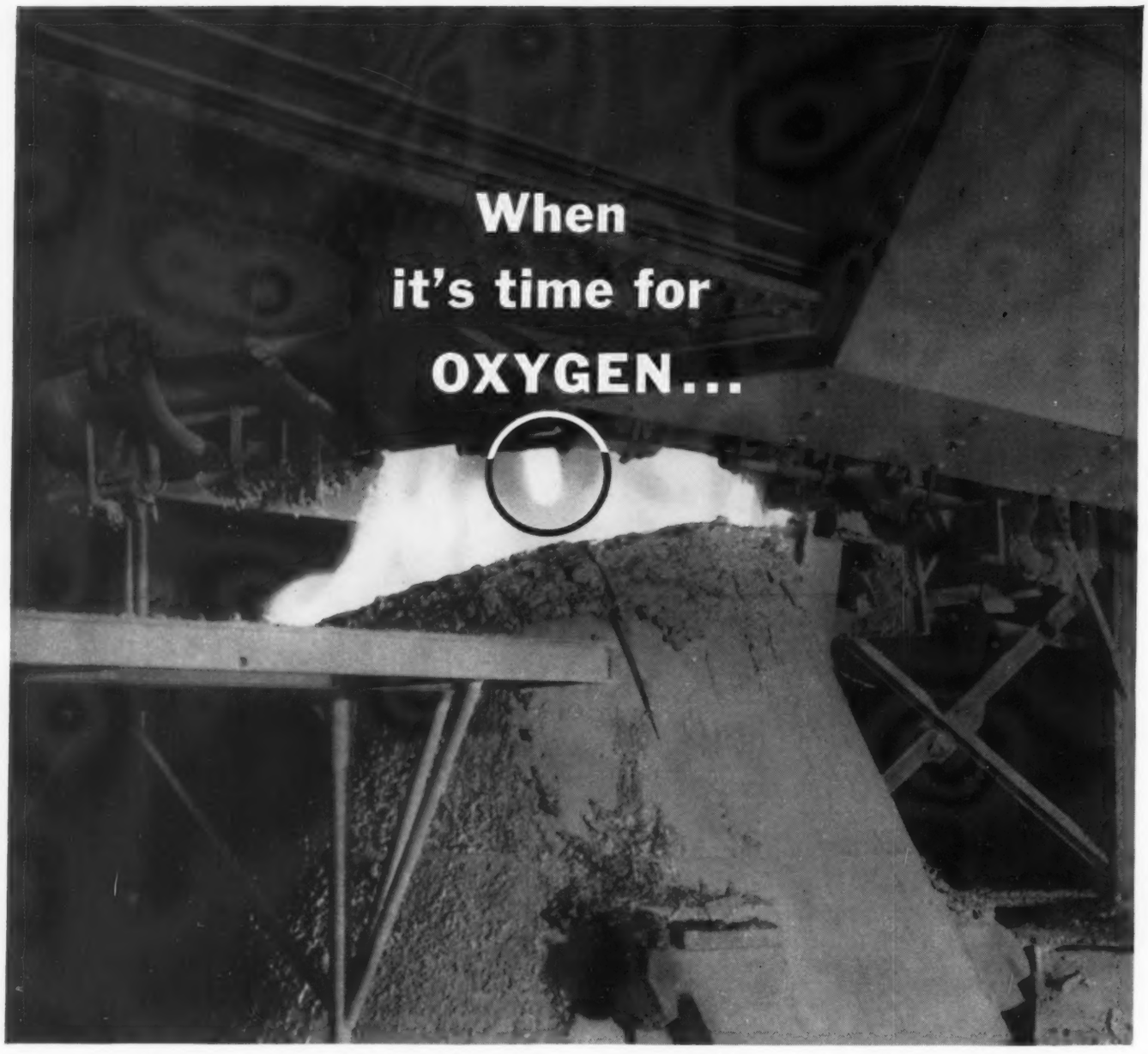

Basic oxygen furnace supplied by an Air Products on-site facility. Oxygen lance is circled. Air Products systems supply oxygen to individual users in tonnage quantities . . . including the largest single oxygen generator ever installed in a steel mill, rated at 525 tons per day.

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. . . Because on-site generating facilities, pioneered and perfected by Air Products, have made oxygen a low-cost utility . . . sliced its price by 80% in the last 12 years.

. . . Because you can profit from Air Products close participation in important technical developments in steel-making . . . from the broad experience Air Products offers from doing business with *all* major industries and defense agencies . . . from Air Products technical service, including development of new oxygen lance techniques.

. . . And because Air Products high-efficiency systems produce and deliver more oxygen at less cost than any other method.

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Acme Steel Inaugurates Novel Steel Mill Operation In The United States

ACME Steel Co. inaugurated operations recently in its new $33,000,000 steelmaking plant at Riverdale, Ill., adjoining Chicago's far south side. This is the first time that steel was produced in the United States or on the North American continent by a combination of continuous hot blast cupolas and top blown oxygen converters. Lower initial capital investment, high quality product and more economical production costs are among the principal advantages of this new steelmaking method.

This new plant, when it reaches capacity operations, will produce a major share of the steel slabs and billets required in the manufacture of the company's products. The new steelmaking plant will contribute substantially to the advancement of Acme Steel Co. in the years ahead by: (1) insuring an adequate supply of raw material at lower costs; and (2) improving quality and service to an expanding list of customers with special steel requirements.

The company became a steelmaker for the first time in 1956 when it purchased the assets of Newport Steel Co. and formed the wholly-owned subsidiary, Acme-Newport Steel Co., at Newport, Ky. This subsidiary produces hot and cold rolled alloy sheets and plates, welded line pipe and spiral welded pipe, operating open hearth and electric furnaces and rolling mills.

Initial capacity of the new steelmaking facilities at Riverdale is 450,000 ingot tons a year. Expansions already planned will raise the ultimate capacity of the plant to more than 700,000 tons per year. The initial capacity, combined with the 600,000 tons annual capacity of the Newport facilities, places Acme among the 20 steel producers in the country having an annual capacity in excess of 1,000,000 ingot tons.

Under construction for nearly two years, the new plant includes a melt shop, where steel is made in a building that houses five bays, each 80 by 450 ft, and covers three and a half acres under roof. Rolling mill facilities—soaking pits, a blooming mill and a billet mill—occupy an additional four acres in a building extending an over-all length of a quarter of a mile.

Acme's complete plant facilities in Riverdale cover an area of 130 acres.

Located in the melt shop are two 10 ft diameter x 67 ft high continuous hot blast cupolas and two oxygen converters. Each of the cupolas rises to a height of 80 ft above grade and can produce from 15 to 50 tons of molten iron an hour. Normally both will be in operation. The materials charged into the top of the cupolas by automatic hoists consists of about 78 per cent assorted scrap and pig iron, 16 per cent coke for fuel, 5 per cent limestone for forming slag, and one per cent fluorspar to keep the slag fluid. Hot blast air enters the cupola at about 1000 F. The tonnage rate of molten iron produced is varied by changing the pressure and volume of hot blast air, and each unit can produce about 50 tons per hr.

Adjoining the cupolas are the two oxygen top-blown converters, each 14 ft in diameter and 25 ft high. They can be rotated or tilted in either direction on a fixed pivot. Molten iron from the cupolas, plus selected scrap, is charged into the huge vessels. Other elements, such as burnt lime, mill scale, ferro-manganese, and ferro-silicon are added in proper quantities just prior to and during the oxygen blow, to accurately produce steel of the desired grade and analysis.

The conversion to steel, is accomplished by inserting a long pipe or lance through the top of the converter and blowing pure oxygen, under pressure, into the hot metal for approximately 20 minutes. About 20 per cent scrap will be used in the change. The complete steelmaking cycle in the converters requires about 40 minutes in normal production and yields between 40 to 50 tons of molten steel.

About 2000 cu ft of pure oxygen is required for each ton of steel produced. It is supplied by a 110-ton per day oxygen generating plant located on Acme property across the Little Calumet River from the new plant site.

Molten steel from the converters is carried in huge ladles, by overhead crane, to a teeming platform where it is poured into ingot molds and allowed to solidify. Most of the ingots will weigh between 10,000 and 12,000 lb although a few will be made weighing about 7,000 lb. Ingots will be mostly 25 x 27 in. or 21 x 23 in., ranging from 62 to 78 in. long.

After the molds are removed the hot ingots are moved in transfer cars to the rolling mills directly south of the building in which the steel is made. The subsequent operations are similar to those found elsewhere in the industry. The ingots are reheated in soaking pits (12 reheating furnaces with temperatures maintained at 2400 F) then rolled on the blooming mill where all slab sizes $8\frac{3}{4}$ in. or wider are finished, cut to length and transferred to the slab yard for cooling and inspection. For narrower slabs, and all sizes of billets, the blooms are fed directly into the billet mill which further rolls the steel down to required sizes without reheating.

Engineered into the new steelmaking facilities are efficient dust and smoke collecting systems available for the cupolas and converters. Also, a water clarification system and filter house will return water used in the steelmaking process in a cleaner condition than when it was pumped out of the river.

This modern cleaning equipment costing in excess of $1,000,000, has been installed by Acme Steel Co. in the interest of the surrounding community. ▲

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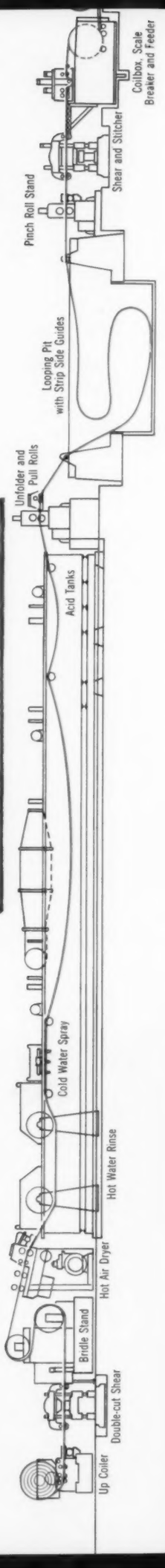
SECO's staff of trained engineers are available for personal assistance. Call us today.



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- Strip Coilers (Up and Down Type)
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SCHLOEMANN

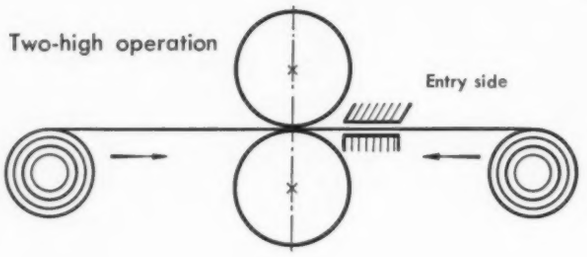
MKW-type strip cold rolling mills for two-high and multi-roll operation

With this type of mill, the work roll diameter can be adapted to a wide range of thickness of the material. In this way, the strip is correctly and thus economically rolled.

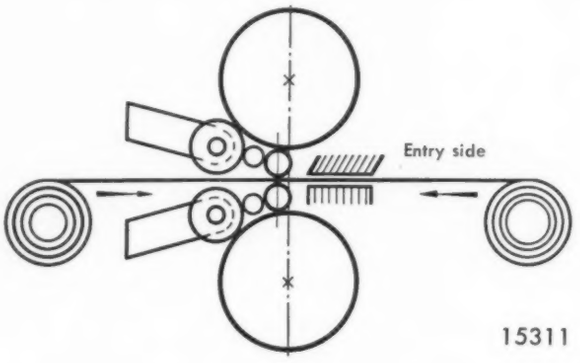
Two-high operation for breaking down very thick strip while using high-strength flow-type friction bearings (DB patent) with composite bearing shells, the bearings being free of play in the vertical direction.

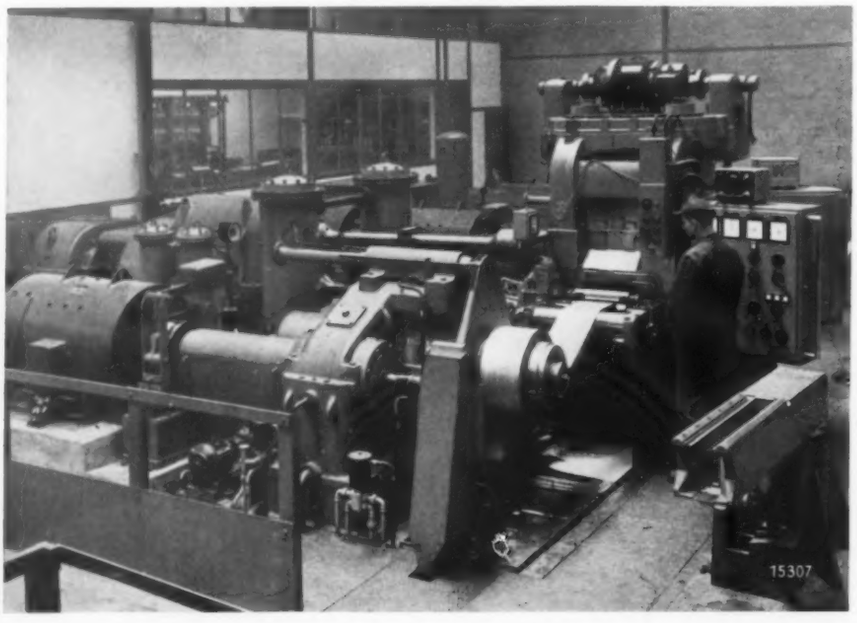
Multi-roll operation for rolling thin or hard strip at high speed, using work rolls of small diameter in order to reduce roll pressure. This results in a very small amount of 'spring' for the housings and permits rolling at close tolerances.

The MKW-type mill (German and foreign patents) allows high torque to be transmitted during multi-roll operation, thus obtaining high pass reductions, in spite of the back-up rolls being driven. Because of the characteristics of the roll arrangement and support, the thin work rolls cannot bend — either in the vertical or horizontal directions. The roll position is determined — even when operating in the reverse direction — by a partial force of the roll pressure, that is to say, the work rolls are forced against the back-up rolls, no matter in which direction the material is being rolled. The roll gap therefore remains unchanged. The entry side is free right up to the roll gap, thus allowing the material to be guided perfectly flat to the work rolls.



Multi-roll operation. Off-centre arrangement of the laterally supported work rolls, strip bridle and entry guide directly in front of the roll gap.





Type U-MKW 32 for steelstrip coil weights up to 560 lbs/in.

Two-high operation:
13 dia x 16 in.
v = 200/500 ft/min
Thickness 0.24 to 0.04 in.

Multi-roll operation:
14/2.5 dia x 16 in.
v = 400/1,000 ft/min
Thickness 0.08 to 0.004 in.

FELLER ENGINEERING CO., 1161 EMPIRE BUILDING, PITTSBURGH 22, PA.

Republic Reveals Strip Process At New Research Center Dedication

REPUBLIC Steel Corp. announced that it is successfully producing strip steel from iron ore, without melting, in the company's new $5,000,000 Research Center, located 10 miles south of downtown Cleveland, Ohio. The announcement was made at the formal dedication of the center recently in Independence, Ohio.

The strip steel rolling process uses iron powder and by-passes such normal production operations as coke ovens, blast furnaces, open hearths and blooming mills.

Republic is extremely optimistic and keenly enthusiastic with results so far, but there is considerable research work still ahead before commercial production will be possible.

Work on the process up to this time has been confined to the laboratory phase. The next stage will be to move to a continuous pilot plant line where larger quantities of materials can be handled.

The steel made in the laboratory offers the same strength, ductility and ability to be fabricated into finished parts as steel produced by other methods.

Republic's announcement is believed to be the first official statement by a steel company concerning the production of strip steel directly from iron ore.

The Republic process consists of three major steps. First, iron ore is highly purified and reduced to metallic iron powder. Secondly, it is funneled between four rolls where it is compressed from a powder into a semi-solid strip by rolling.

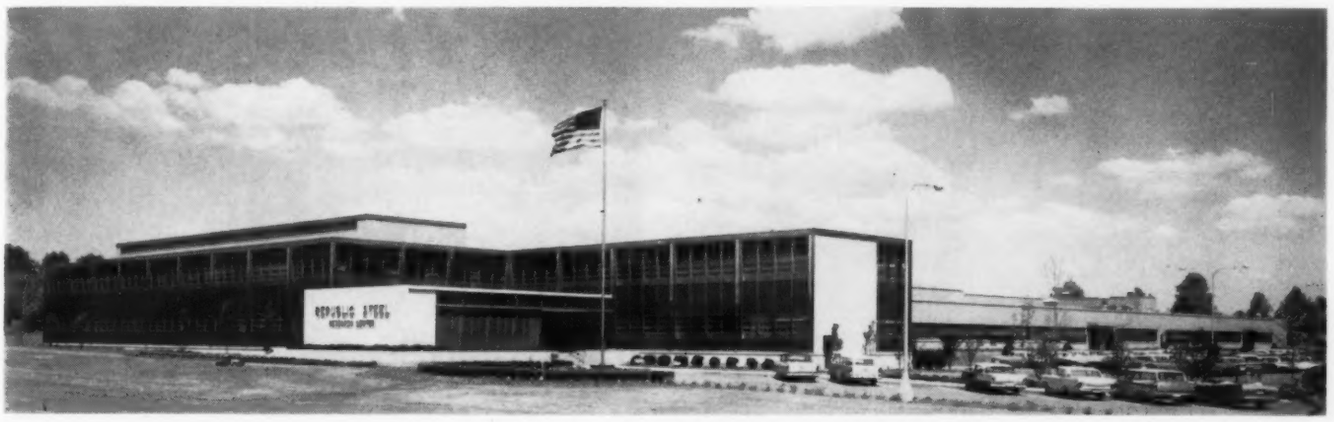
Finally, the semi-solid strip which emerges from step two passes through a furnace where it is heated to 2200 F in a reducing atmosphere and passes on through a series of hot strip rolling stands. This hot rolling step reduces the thickness of the steel strip to the desired gage and to full density and produces hot rolled steel in coils. The hot rolled coils have the same quality as conventionally made steels.

After the hot rolling and coiling operation, the steel then goes through the usual operations of pickling, cold rolling and annealing before being recoiled or cut into sheets.

Republic has produced more than 1800 lb of steel by the new process in the laboratory and tests to date clearly show a quality steel can be made by this method.

The new strip process is only one of a number of important research

Figure 1 — Republic Steel Corp's new Research Center was formally dedicated on June 18, 1959.



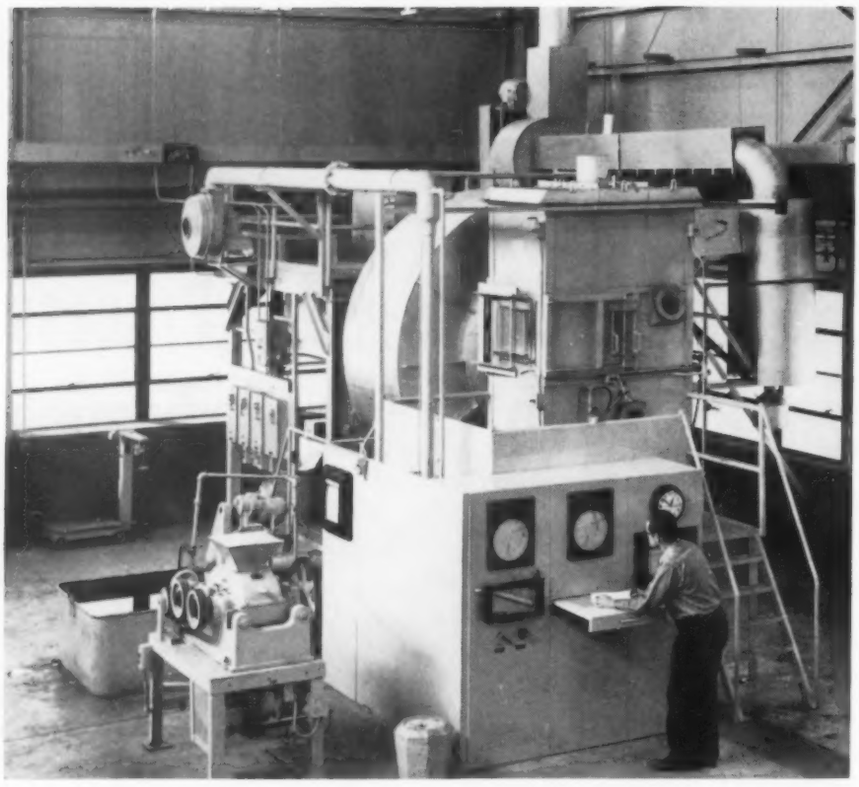


Figure 2 — With this equipment at Republic Steel Corporation's new Research Center, low grade iron ores are heated with coke "fines" and reduced to metallic iron. The reduced ores later are purified to an iron powder suitable for pressing into finished parts.

projects under way at the new Research Center which was dedicated to C. M. White, Chairman of Republic Steel Corp., in recognition of his long standing interest in research, especially into better ways of producing steel.

Some of the important units are: a two-story research building with 41,500 sq ft of floor space which includes a large meeting room, modern library, four meeting and conference rooms, executive and administrative offices, a well equipped photography studio, and an ultramodern drafting room in addition to the laboratories. A one-story development building, which adjoins the research building, has approximately 73,000 sq ft of space containing an R-N unit for beneficiating iron ore, a miniature coke oven, heat treating furnaces, a 1000-lb capacity electric arc furnace for steelmaking, a six-pound vacuum melt steelmaking furnace, rolling mills and a forging and extrusion press. In addition, adequate space is available for future pilot plant projects.

Budgets and schedules set up for the new center call for a "30-30-30-10" formula.

Roughly speaking, 30 per cent of the budget will be applied to research projects designed to show results in one to three years. Thirty per cent will be applied to exploratory projects keyed to a five-year schedule, and another 30 per cent will be allocated to long-range study projects that may run ten years or more before paying off.

Ten per cent of the budget will be allocated to pure science—fundamental research projects which have no immediate application, but which are expected to produce knowledge which will be useful at some future date.

The work now being undertaken in the laboratories is divided into four areas: metallurgical, processing, new products and ceramics.

These divisions of work are not hard and fast in order to achieve the maximum flexibility and co-operation within and between the various groups.

The laboratory is now fully operative, equipment and facilities having been moved from former locations or delivered from equipment manufacturers over the past six months. ▲

Figure 3 — Actual steelmaking on a small scale is conducted at the new Research Center. One of the many important phases of work being carried out at the center is the development of new compositions of refractories to be used in steel producing operations.

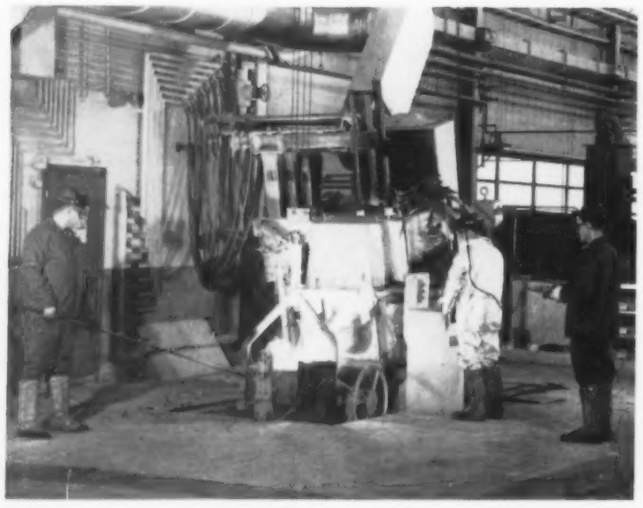
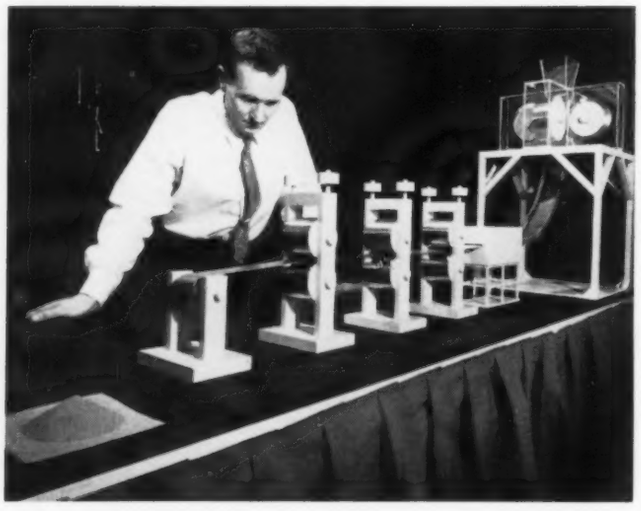
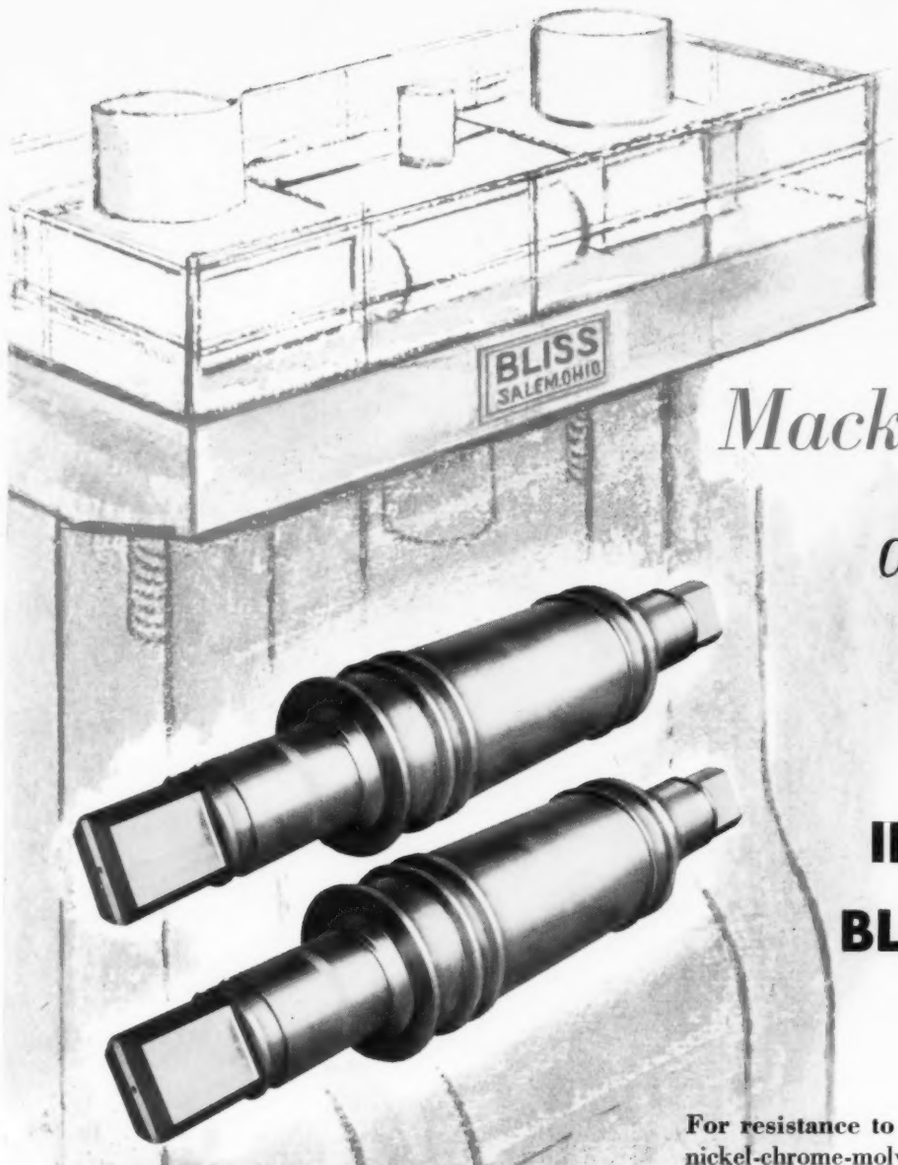


Figure 4 — Model shows the operating sequence of Republic Steel Corp.'s new strip steel rolling process in which highly purified iron powder is turned into strip steel without melting.





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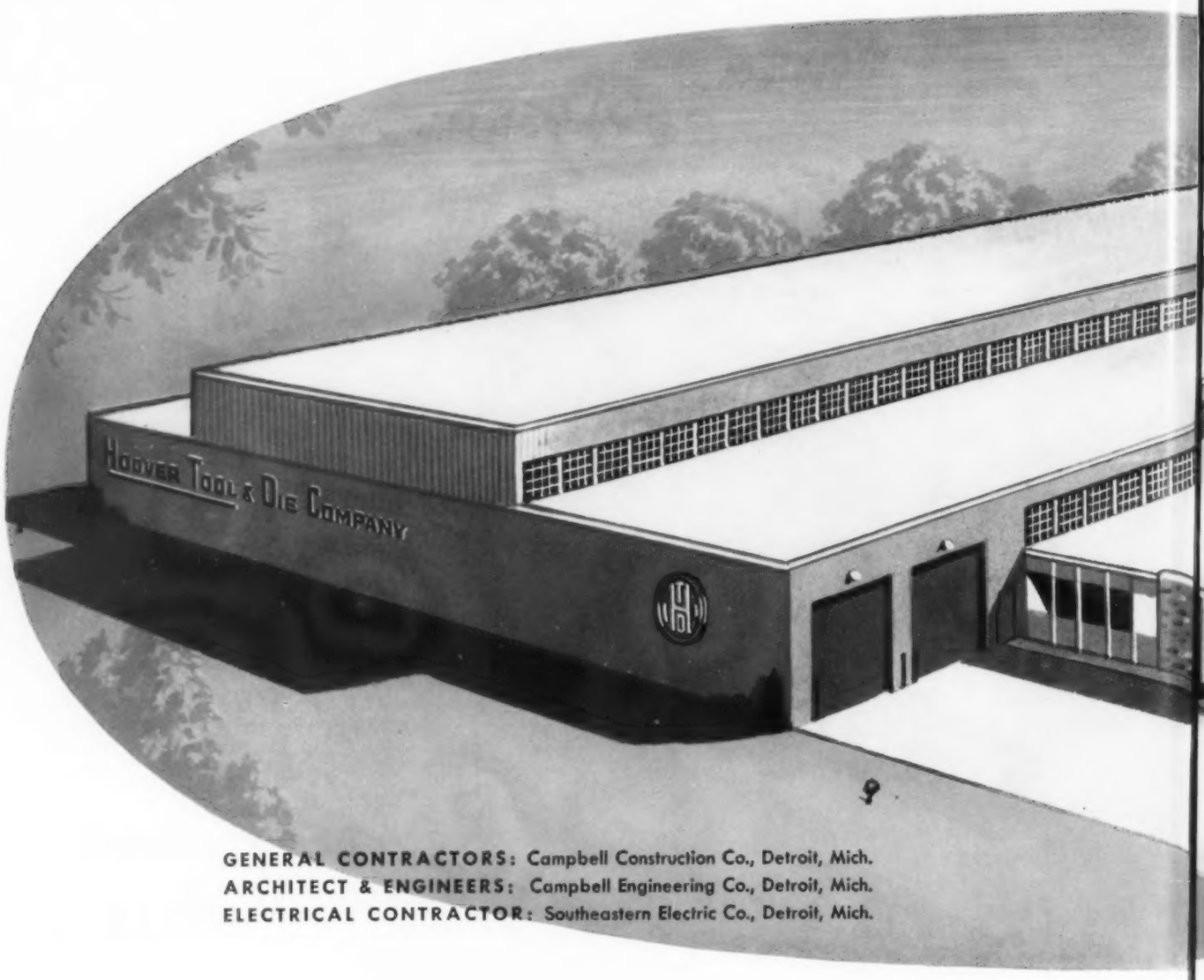

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Electrical Protection goes MODERN *with* BUSS Fuses

in the Hoover Tool & Die Co., Centerline, Mich.

This new industrial plant on the outskirts of Detroit illustrates that the modern trend in electrical protection is to fuses. The main switch gear is a 1600 ampere pressure switch protected by BUSS Hi-Cap fuses. The distribution panels, both power and light, are equipped with FUSETRON dual-element fuses.

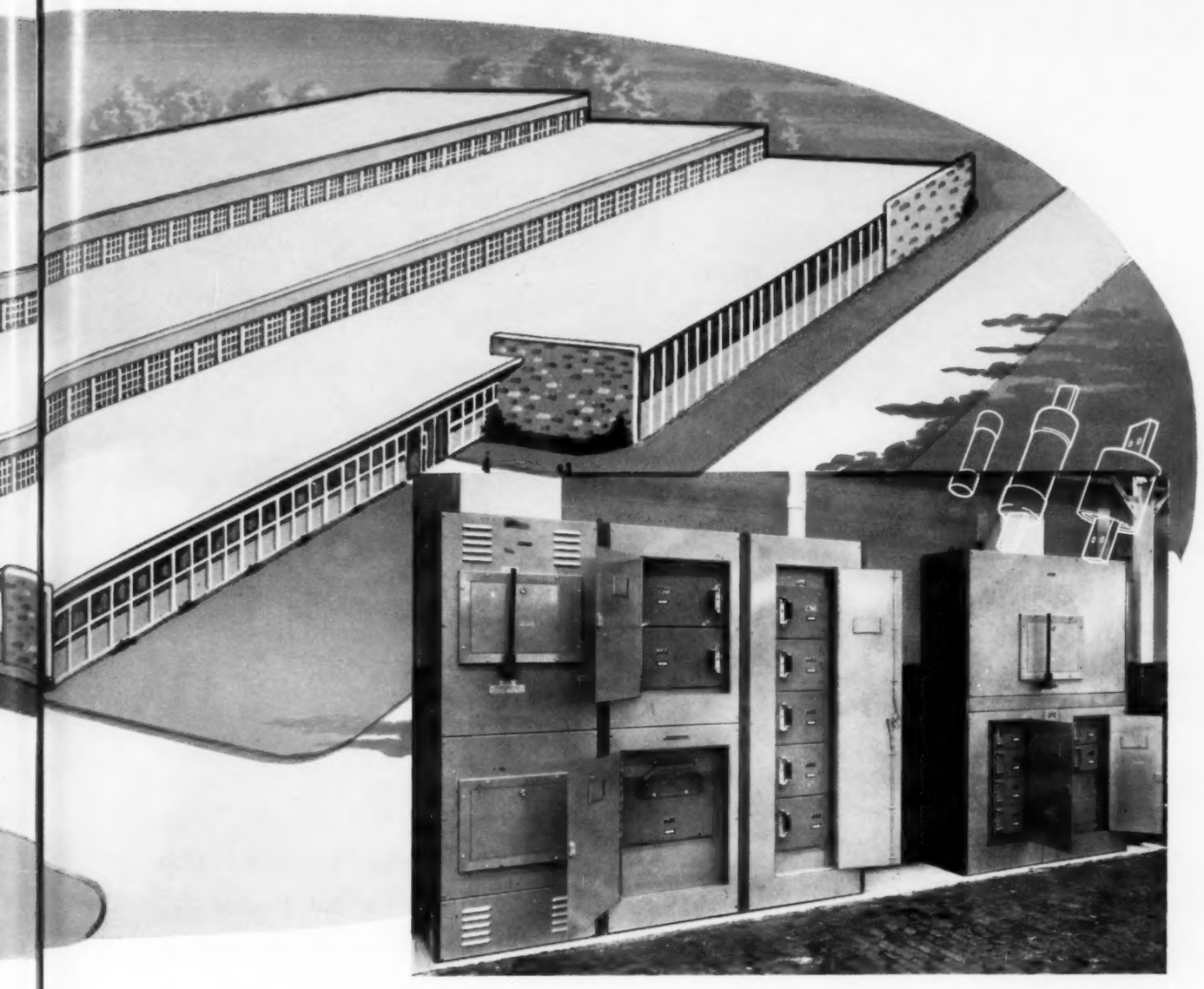
This plant will have many operating advantages because fuses are installed. *For instance:*

Future expansion without sacrificing safe protection.

Provisions were made to install a second 1600 ampere pressure switch when needed. This additional capacity and any increase in available fault current can safely be handled by BUSS Hi-Cap and FUSETRON dual-element fuses.

The interrupting rating of BUSS Hi-Cap fuses is 200,000 amperes rms symmetrical — and for FUSETRON fuses it is 100,000 rms symmetrical.

ANOTHER BUSS HI-CAP AND FUSETRON FUSE INSTALLATION



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Unlike mechanically operated devices, a fuse has no hinges, pivots or contacts to stick or get out of order. Dust, fumes, corrosion or age cannot increase a fuse's capacity or lengthen its blowing time.

After years of service, a fuse will give the same safe, dependable protection if called upon to open as it would have given on the day it was installed.

The dependability of BUSS Hi-Cap and FUSETRON fuses helps to reduce costs — by preventing damage and loss due to electrical faults — by being maintenance free — by requiring no periodic inspections — and by eliminating shutdowns caused by needless outages.

Is it any wonder then that "ELECTRICAL PROTECTION IS GOING MODERN WITH FUSES"? No other type of protective device can match the combined high-interrupting capacity, dependability and maintenance-free features of fuses.

For more information

On BUSS Hi-Cap fuses . . . . *Write for bulletin HCS*

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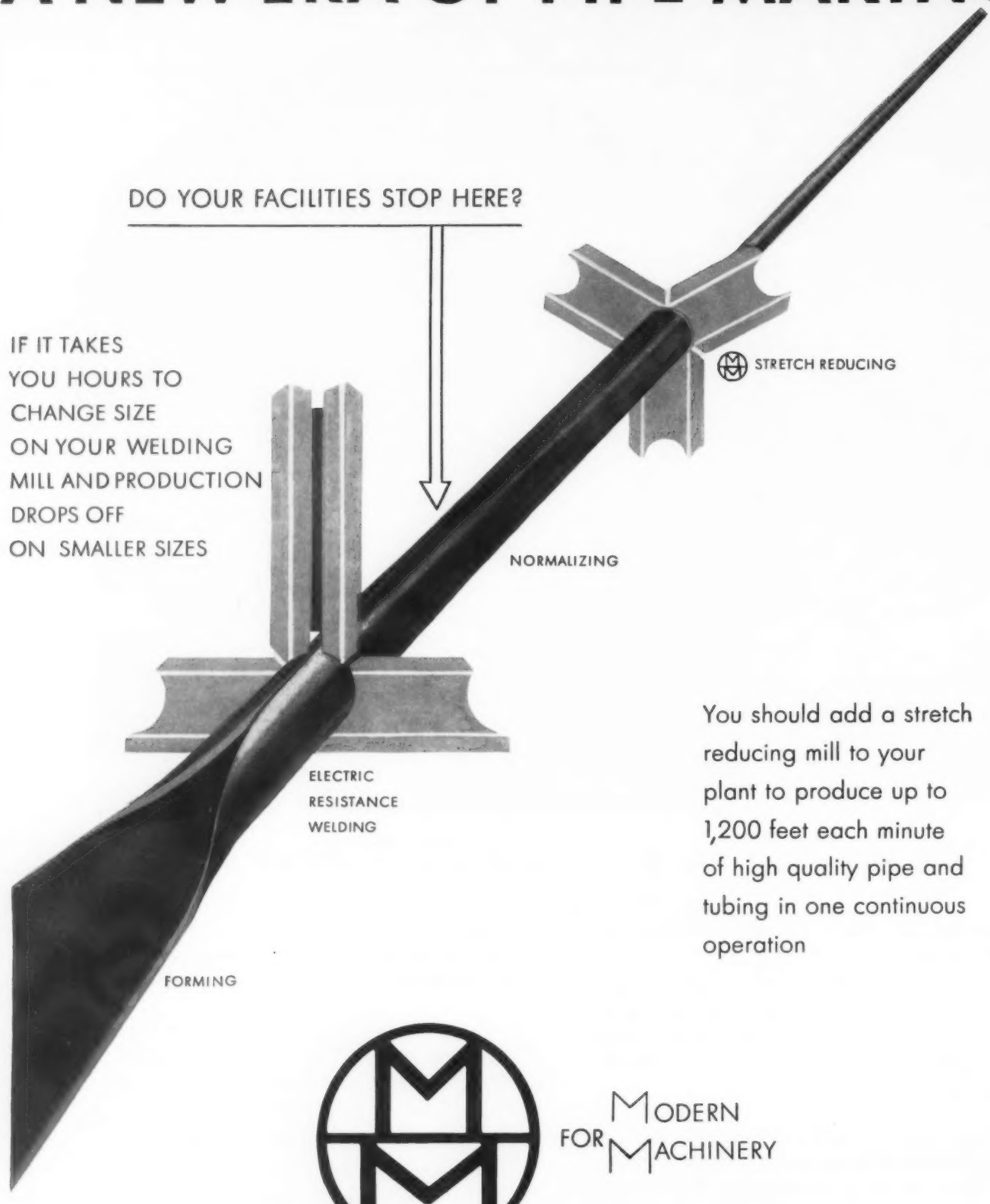

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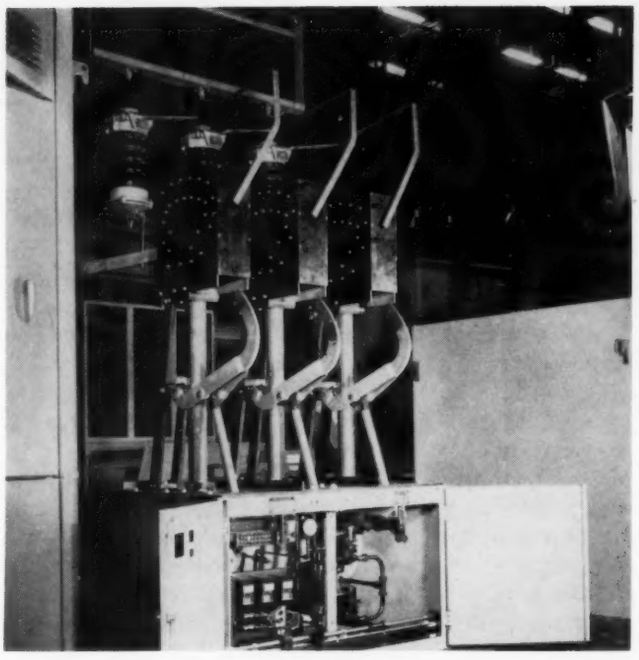

Figure 1 — Compressed air breakers for arc furnace switching have many advantages.

Figure 2 — Visual inspection can be easily made of compressed air-breaker contacts.

Compressed Air vs Oil Circuit Breakers for Arc Furnace Switching

by J. E. Schrameck, Manager, Compressed Air Breaker Section,
Power Circuit Breaker Engineering,
Westinghouse Electric Corp., East Pittsburgh, Pa.

TWO major factors complicate the application of circuit breakers to arc furnace switching. These are: (1) the circuit breaker's repetitive duty that requires outstanding mechanical integrity and; (2) the circuit severity that requires the most efficient interrupting means. These considerations are particularly important when the cost of furnace downtime in lost production is charged to the circuit breaker. Also, the mechanical and electrical requirements are recognized to be unusually severe when compared to normal power system circuit breaker duty. Therefore, special design features are incorporated in the arc furnace circuit breaker.

Electrically, the highly repetitive operation, in conjunction with related extra arcing time due to severe circuit conditions, means faster accumulation of carbon in oil circuit breakers, faster increase in acidic content, and faster reduction in dielectric strength of the oil.

This means oil circuit breakers are penalized for this vigorous application by requiring more frequent inspections, more frequent checking and reconditioning of the oil and more frequent cleaning to remove precipitated freed carbon from insulating surfaces.

Of course, the mechanical dependability could be built into an oil circuit breaker as is done with compressed air circuit breakers, but this is not justified because of the oil maintenance factors. Thus, the oil circuit breaker remains an excellent device in the power systems field, but is limited for arc furnace switching duty.

The following elements of a circuit breaker require special con-

sideration when the unit is to be applied on arc furnaces switching:

1. Mechanism.
2. Interrupting medium.
3. Interrupters.
4. Contacts.
5. Insulation.
6. Ease of inspection.
7. Accessibility.
8. Auxiliary devices.

MECHANISM

The mechanism is vulnerable to the large number of operations required. Primarily this vulnerability results from failure of locking devices, fatigue failure of pins and linkages, wear and elongation of bearing points and holes, the abrasive effects of contaminated atmospheres and inadequate provisions for lubrication.

Although laboratory tests are indicative of mechanical integrity, actual field conditions have demonstrated the need for further refinements. For instance, cotter pins have sheared requiring the substitution of shoulder pins and castellated nuts or elastic stop nuts. Keyways have sheared requiring increased proportions to withstand the shearing stresses. Inserts have been added to holes around pins to provide hardened bearing surfaces, and the pins themselves have been changed to more wear-resistant materials. These hardened materials along with lubrication fittings were designed to resist the abrasive action of particles in the steel mill atmosphere.

Thus field experience has brought about mechanical design changes which have developed because of conditions peculiar to the application, or because production manufacturing processes did not duplicate the conditions of materials under which laboratory tests were made. These all have brought about improvements in mechanical details that have not been possible with the limited application of oil circuit breakers to this service, and have promoted the superiority of compressed air breaker mechanisms.

INTERRUPTING MEDIUM

The compressed air circuit breaker uses compressed air for interruption. This, unlike oil, is automatically conditioned by the process of supplying compressed air to the circuit breaker. It is dried by drying equipment or the expansion process of supplying air from a high-pressure storage to the circuit breaker. It is filtered or dehumidified by mechanical means if air is taken from a "shop" supply at essentially breaker operating pressure.

Actually, the air is used only once. It is discharged from the breaker, carrying with it contaminants, if any, which will not be recirculated through the interrupters.

Interruption does not depend upon the chemical disassociation of air molecules as in the case of oil, and, of course, there is no residue from such a chemical action which can be deposited on insulation.

Since compressed air is discharged through the circuit breaker in metered quantities sufficient to obtain interruption at maximum currents, the interrupting effort is independent of the current to be interrupted. This means that extra cycles of arcing at low currents will not occur in compressed air circuit breakers, with corresponding deterioration of contacts and other critical parts.

INTERRUPTERS

The usual compressed air arc furnace breaker uses fiber splitters against which the arc is forced by the air blast. This breaks up the arc into one or more sections, each contributing to the interrupting effort. Another type uses one or more orifices into which the arc is blown by the compressed air. The splitter type probably has been more widely used.

The splitter-type interrupter, as well as the orifice-type, is subject to erosion. That is, the fiber splitters and other parts of the interrupters are momentarily vaporized locally by proximity to the arc and the volatile is blown away by the air blast. This, of course, is true of the oil circuit breaker interrupters. However, because the compressed air breaker has been accepted for arc furnace switching, interrupter design has been developed to minimize these effects. That is, inserts of highly arc resistant materials have been added to the vulnerable points to provide protection, and certain of the splitters have been made of this material. Such development is not economically justified for oil circuit breakers.

Thus with compressed air breakers, thousands of operations can be made without repair of interrupters. Probably 50,000 operations or more could be obtained without repair; however, this is a function of the particular furnace load being handled. Further, the compressed air breaker interrupter generally is simpler than the oil circuit breaker interrupter, so that frequently certain parts, such as splitters, can be replaced without dismantling the complete interrupter.

The vagaries of an arc furnace circuit are not well defined, nor predictable. Circuit constants cannot be accurately determined, and random transient voltages have occurred causing failure of circuit breakers and other devices. Again, due to development on compressed air circuit breakers as special arc furnace switching devices, most splitter-type interrupters are supplemented by surge suppressors connected to probes built within the interrupters, so that random or repeated transient voltages are dissipated without harm.

CONTACTS

Experience has shown that standard contact arrangements may not be adequate for arc furnace switching. For instance, on Westinghouse compressed air arc furnace breakers, the contacts have been modified to provide a better air sweeping action. This insures that arcing occurs at the intended points. Further, additional protection afforded by silver-tungsten inserts has been found to be necessary, when standard contacts eroded away too quickly. Even arc resistant inserts of standard contacts have had to be enlarged to provide satisfactory contact life. Such contact design is not economically feasible for breakers not intended for arc furnace switching duty.

INSULATION

The main point to consider under insulation is that fundamentally air is used for compressed air breakers and oil is used for oil breakers. This results in the following plus advantages for compressed air:

1. Consistently cleaner insulation.
2. Greater accessibility of other

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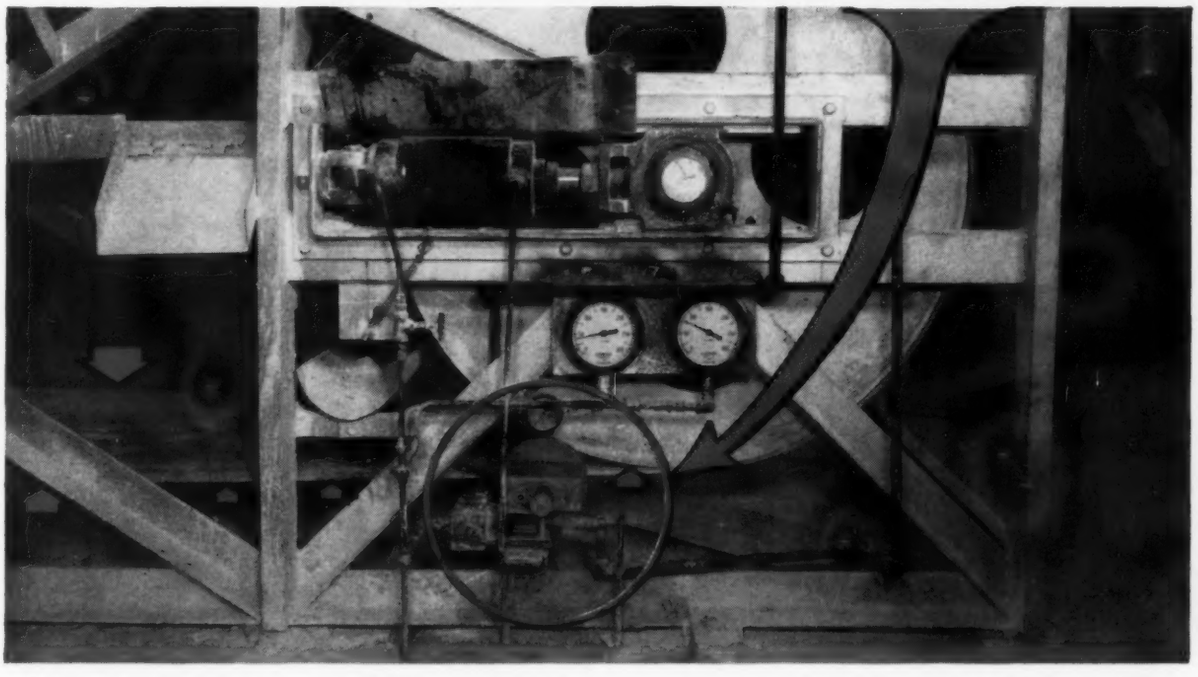
Hydraulic Edge Guide & Tension Control

A producer of ceramic products was experiencing torn and distorted belt edges like this on its conveyor type slurry dryers. The heat needed for rapid drying made frequent adjustments necessary to maintain correct tension and alignment of this stainless steel belt...



...now this plant uses North American Hydraulic Controls to maintain the smooth straight edges shown in this unretouched photo. A single North American Regulator continuously maintains true belt tracking while holding a constant tension on the belt despite stretching or contraction. Even an operator who is a perfectionist cannot match the perfect job done by North American's automatic controller which constantly senses and corrects for extremely small irregularities.

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supporting insulation for inspection and maintenance.

3. Less dismantling for inspection and maintenance of supporting insulation.

EASE OF INSPECTION

Since the contacts, interrupters and operating members are surrounded by air and not oil, it is not necessary to lower oil tanks or to drain oil to inspect them. Thus compressed air breakers, surrounded by a transparent medium, air, are quickly inspected visually. Any need for maintenance may be determined from a quick and visual inspection, and plans made accordingly.

For instance, the rate of erosion of splitter plates, as in a splitter-type interrupter, may be observed through the slot in the arc chute provided for the moving contact.

The stationary contacts also can be observed through the arc chute slot. The moving contact, completely withdrawn from the arc chute can be easily inspected.

In an orifice-type compressed air breaker, retracting means are provided so that the moving contact can be separated from the stationary contact for easy inspection.

Thus without dismantling, conditions of interrupters and contacts can be determined so that the next need for maintenance can be predicted along with what new parts will be required.

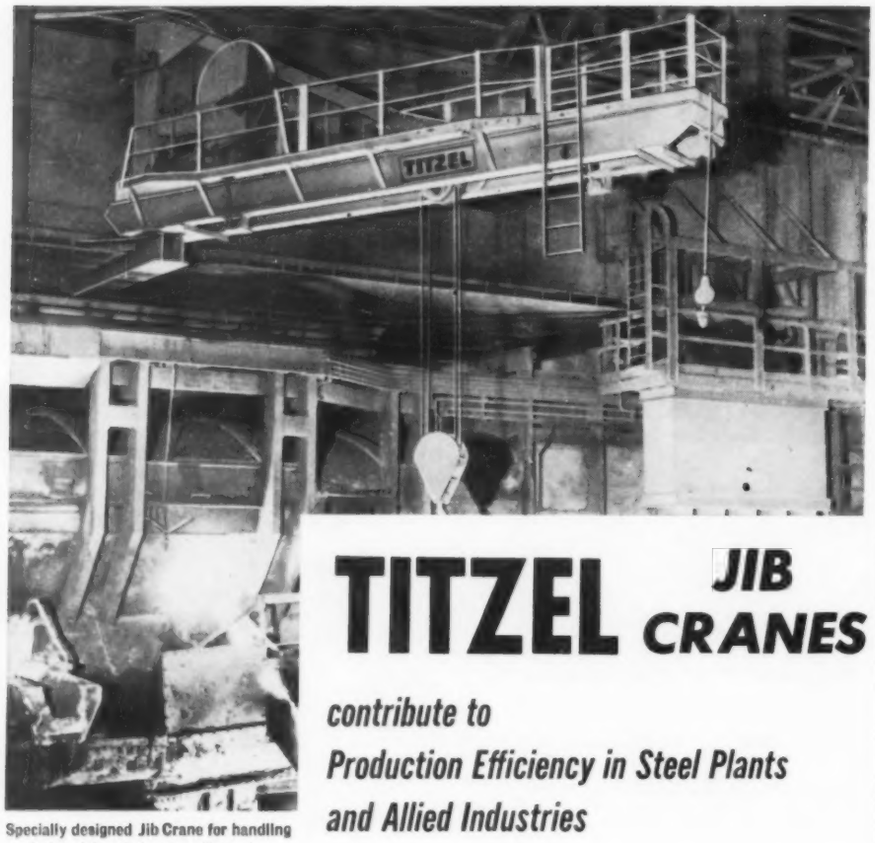
Similarly, since all working parts are surrounded by air, the condition of pins, links, bearings, lubrication, etc., can be determined with a minimum of dismantling.

ACCESSIBILITY

From the foregoing, it is apparent that accessibility is a factor favorable to compressed air circuit breakers. With the open construction of a compressed air breaker, with no oil tanks, a complete arc chute can be replaced between heats, such as during charging of the furnace. Similarly, moving or stationary contacts can be replaced. Adjustments, indicated by short-time inspections can be made. In fact, the open-construction of the compressed air breaker naturally lends itself to the fastest possible reconditioning when task-force maintenance moves in to accomplish a job with minimum downtime.

AUXILIARY DEVICES

The usual point of view is that compressed air breakers require compressor equipment, which in turn requires more maintenance. This is not necessarily true for several reasons. One is that the breaker, in some cases, may be operated from existing plant air supply; hence, no additional maintenance of air supply equipment is required. Also, many modern oil circuit breakers are pneumatically operated, so there exists the need for pneumatic maintenance. Further, the equipment needed for oil breaker maintenance such as pumps, filters, oil storage and oil test equipment, may counterbalance the requirement of compressor equipment. In addition, experience at arc furnace breaker installations has shown that modern air supply units are rugged devices which continually deliver air with a minimum, almost negligible, amount of maintenance. ▲



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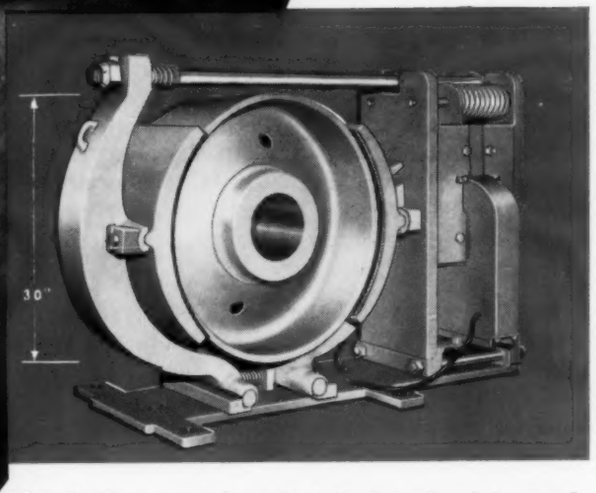

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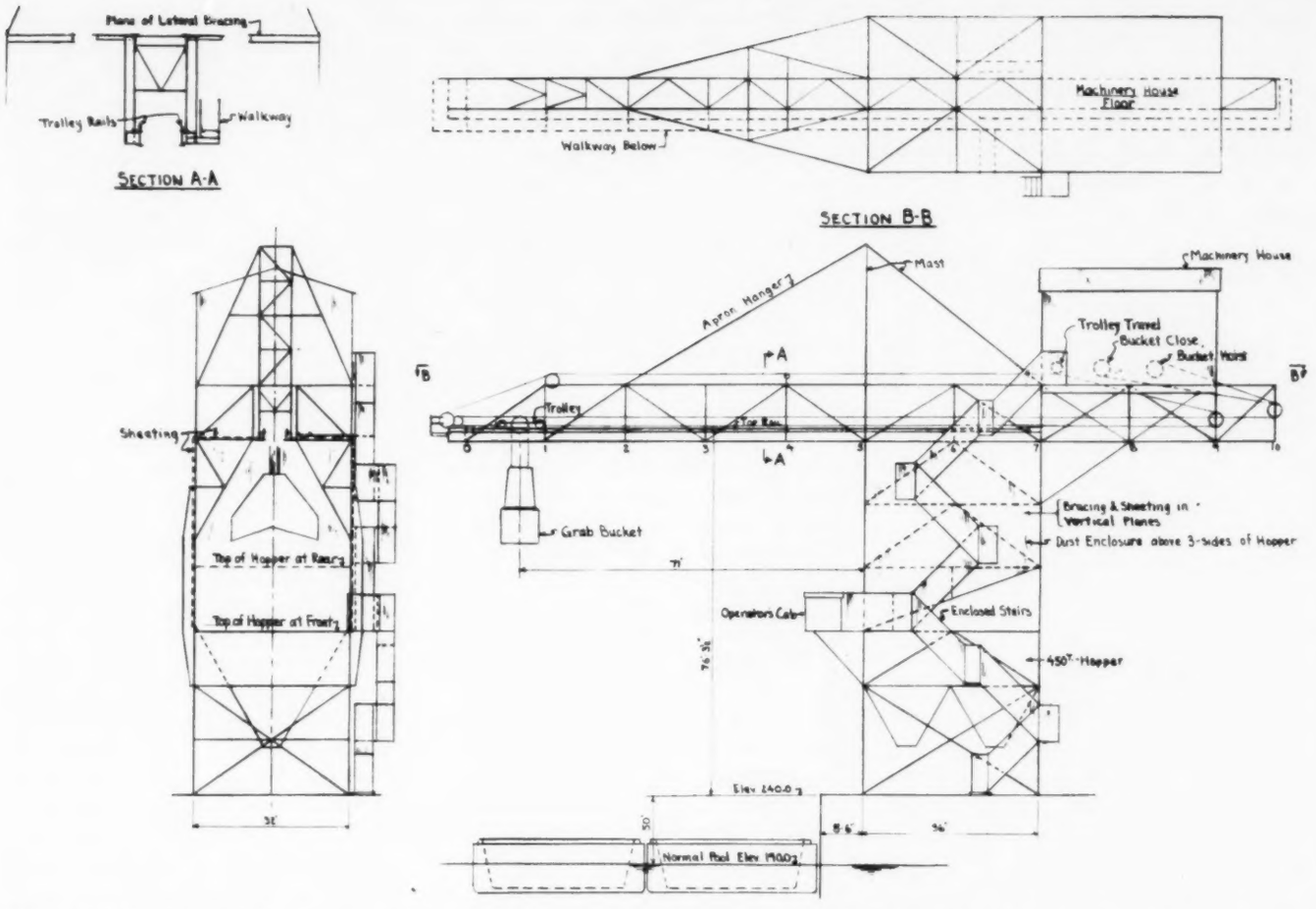


Figure 1 — Conventional type coal unloader has boom of rectangular cross section braced by an apron hanger and mast. It has been built in both welded and riveted designs, service experience favoring the former.

A SIAMESE TWIN COAL UNLOADER

By Samuel K. Stellfox, Structural Engineer, Dravo Corp., Pittsburgh, Pa.

. . . . . this article is based on an award-winning paper submitted in a recent Machine Design Competition sponsored by the James F. Lincoln Arc Welding Foundation, Cleveland.

COAL unloaders recently completed for the new Thos. H. Allen Electric Generating Station, the municipally owned plant of the Memphis Light, Gas & Water Division, are novel by virtue of a Siamese-twin design, with two unloaders integrated in one tower. Further, the two booms are of triangular cross section, as opposed to the conventional rectangular type, and are of fully arc welded or "monolithic" construction. End result has been appreciably less cost, lighter weight, more rigid structure, lower maintenance cost and a more compact and functional appearance.

Representative of the structure under discussion, Figure 1 is a conventional type unloader, with single boom of rectangular section. Significant features are the following:

1. Grab bucket and trolley are rope operated.
2. Bucket dumps its load into a 450-ton hopper having two bottom sections.
3. Machinery house is to the rear and atop the structure.
4. Cross section of the trolley runway is rectangular as shown in section A-A.
5. Support for the apron or boom is by means of a hanger to the top of the mast.
6. Stairway system is enclosed and dust protection is provided above and on three sides of the hopper.

It will be noted that bucket reach is 71 ft, distance from the top of the trolley rail to the foundation level is 76 ft 3½ in., and the tower structure is 32 ft wide by 36 ft deep.

The same elevation, front view

and sectional drawings of the new twin unloader, Figure 2, show at a glance the changes and new features incorporated in the design. Basic dimensions—bucket reach, runway height, tower dimensions, etc., are the same, but the following variations may be noted:

1. The Siamese-twin feature, shown in the front view.
2. The lowered machinery house.
3. Main boom compression struts are used instead of apron hanger and mast.
4. The triangular cross section of the trolley runway is indicated in section A-A.
5. Stair flights are much shorter.
6. Sloping plane of the truss sheeting is shown at the top of the front-end view.

In preparing bids on the job, Dravo had the option of offering two completed unloaders, separated at about 90-ft centers, or side-by-side at a single location. Customer preference was for the latter, principally because of lower cost, more rigid design and reduced maintenance.

Analysis showed that the Siamese-twin arrangement permitted a saving of 37,900 lb of structural steel which, using an average of 16¢ per lb for fabricated material, meant a cost saving of $6100. This accrued from such factors as the elimination of practically two planes of side bracing in the lower portion of the tower; using a common support for machinery houses and a common side for the hoppers; and elimination of two sides of enclosure, two sides of machinery house framing and two sides of house sheeting.

In addition to the structural savings, the elimination of a repair hoist in the machinery house and conduit leads and windows, plus miscellaneous items, brought total cost reduction of the Siamese-twin arrangement to $8400.

Since these figures are based on arc welded steel construction for both alternates, they do not reflect any cost reductions which welding might afford over riveting. However, any advantages in favor of riveting, by virtue of less severe fatigue strength requirements, would not be realized in tower members common to both unloaders, since these elements are in the lower portion of the tower where stress variation is at a minimum due to high dead load values.

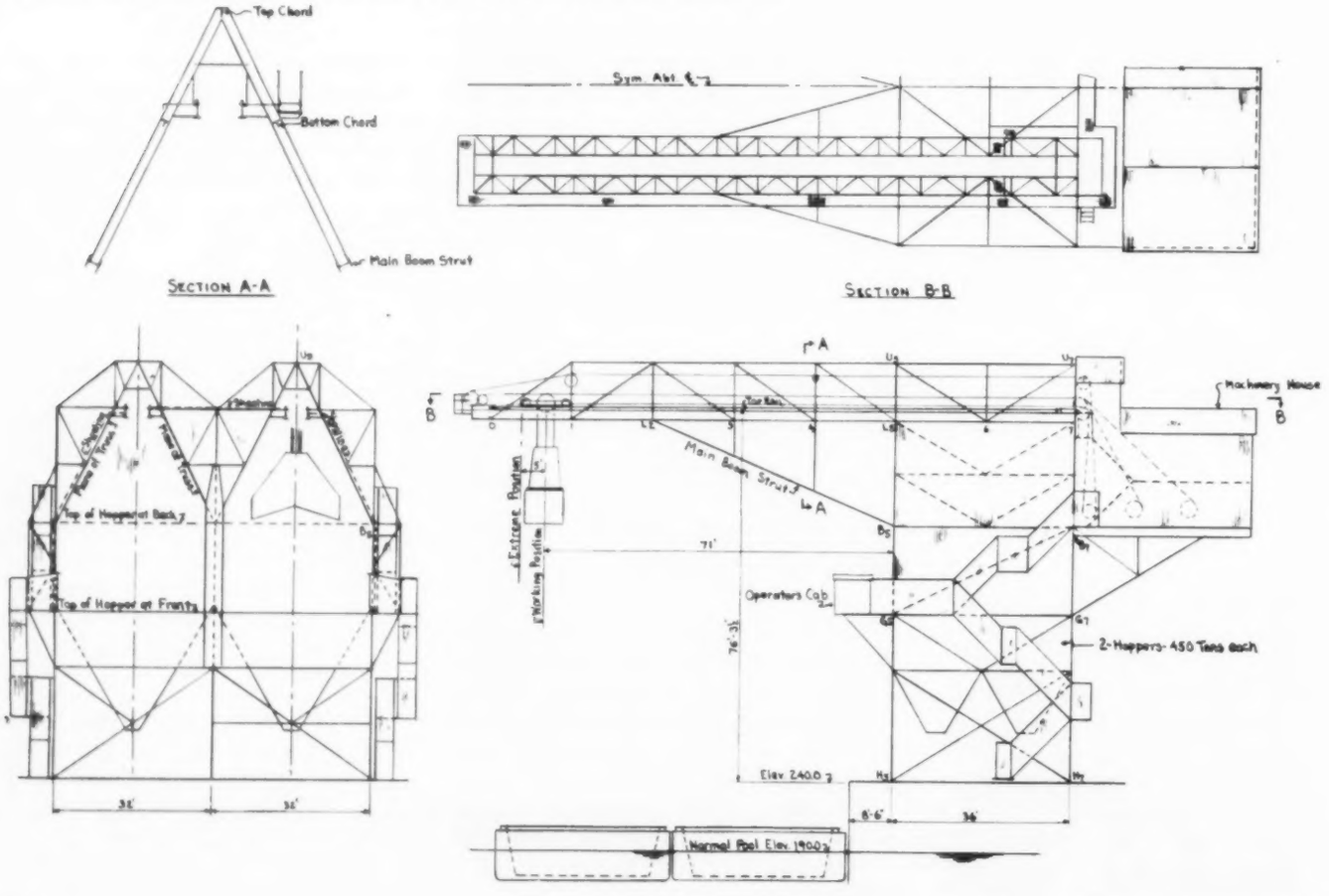
On the score of rigidity, it can be seen that side wind loads, for example, act on a 64-ft base with the twin unloader, instead of 32 ft in the single design, thereby cutting wind pressures almost in half and reducing sidesway tendency.

Machinery maintenance problems are eased in the twin-tower arrangement, since crews servicing the equipment have the benefit of centrally located units, with ready access to all moving parts.

SIMPLIFIED STRUCTURE

Use of the triangular boom in unloaders follows the trend of other monolithic applications of arc welding. One piece is made to serve combined functions. In this case, the main boom strut replaces the hanger and mast, and gives lateral stiffness to the boom. The cross frame posts, in addition to supporting the track beam, afford

Figure 2 — Siamese-twin unloader has two booms of triangular cross section, supported by compression struts. All arc welded, it has lower first cost, is more rigid, requires less maintenance.



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lateral support to the top chord, now one member instead of two as in the rectangular section.

Comparison of Figures 1 and 2 shows these additional factors of simplification: the new tower is lower; there is less exposed wind area; less dust enclosure sheeting and framing are required; fewer members in the new design; and a more direct stress path between load and foundation.

From a practical standpoint, the use of a triangular boom permits each assembly to be erected atop a previously placed section. Lighter weight and fewer pieces mean fewer lifts. The lower tower means erection equipment need not be as hefty; cranes with shorter booms can be used. Lighter weight and greater stability reduce foundation problems and balancing requirements which sometimes necessitate counterweighting. Substantially less area of structural steel has to be painted. The inverted-Vee effect gives each runway a lateral stability of its own, not inherent in the hanger support of earlier designs.

Weight comparison of the runway and upper tower structures for the triangular boom design and old designs of both welded and riveted types is as follows:

	Lb
Triangular welded	145,000
Conventional welded	194,000
Conventional riveted	199,300

CROSS FRAMES

The cross frame of the new design is sketched in Figure 3. Sideposts serve primarily as bending members but, being part of the truss, do receive a direct load. The bending stress is due to vertical eccentricity only, since the lateral bracing system accommodates lateral loads. Both in the new and old welded designs, unit stresses are kept low to satisfy fatigue requirements. Although riveted cross frames are not held to the low unit stresses of the welded, they are kept within 16,000 psi to be consistent with practical considerations. Highest tension stress on the welded frames is 10,000 psi, comprising direct stress of 2610 psi and bending stress of 7390 psi.

TRUSSES

In the triangular truss, there is but one top chord. In all cases, Tees cut from wide flange beams serve as top chord members, the symmetry of the Tee lending itself to the single-web truss construction. For the conventional welded truss, web members, being in a vertical plane, can be fastened to the stems of the Tees with fillet welds. Where depth of the stem does not permit full strength development of connecting members, gussets are butt welded to the Tee to provide the needed surface. In the riveted construction it is necessary to provide gussets lapped over the stem.

In both welded designs, splices in the top chords are full butt welds in the panel containing the smaller chord section and as near to the joint as possible. For the triangular boom, butt-welded Tees also form the bottom chord, while in the conventional design, the bottom chords are angles clipped to the lower flange of the track beam.

On the basis of extensive experience in the construction of unloaders, the following is a generalized summary of over-all costs for runways and upper towers for the three designs under discussion:

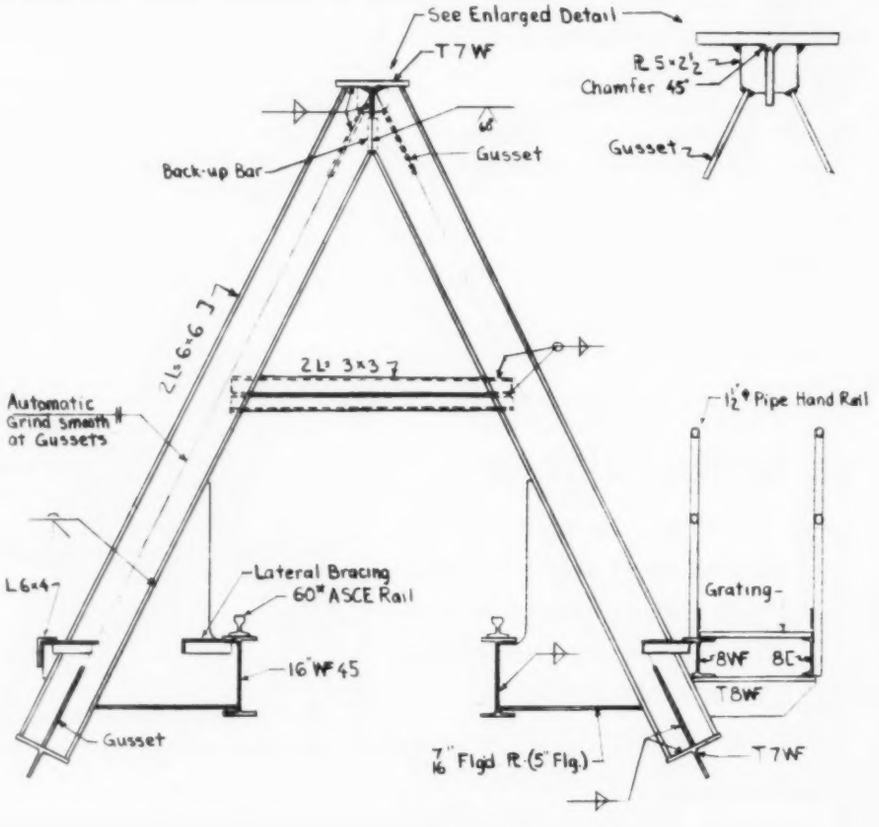
Triangular welded $36,000
Conventional welded $45,000
Conventional riveted $48,000

Significance of the figures should be confined only to their comparative values. Thus, the conventional welded design figures to 93.5 per cent of the riveted, while the triangular is only 75.5 per cent of the riveted.

STRUCTURAL MAINTENANCE

A principal factor contributing to the preference for welding over riveting in outdoor material handling equipment is corrosion resistance. Located along humid waterfronts and in atmospheres frequently high in acid fume content, structures such as unloaders are extremely vulnerable to rusting. Adjacent edges between riveted components form ledges where water

Figure 3 — Typical welded cross frame of the new twin unloader, shows welding detail. Sideposts comprise two angles each, automatically arc welded on both sides down the center to form a 11½-in. channel.



WELDED
TYPICAL CROSS FRAME
Scale ½" = 1'-0"

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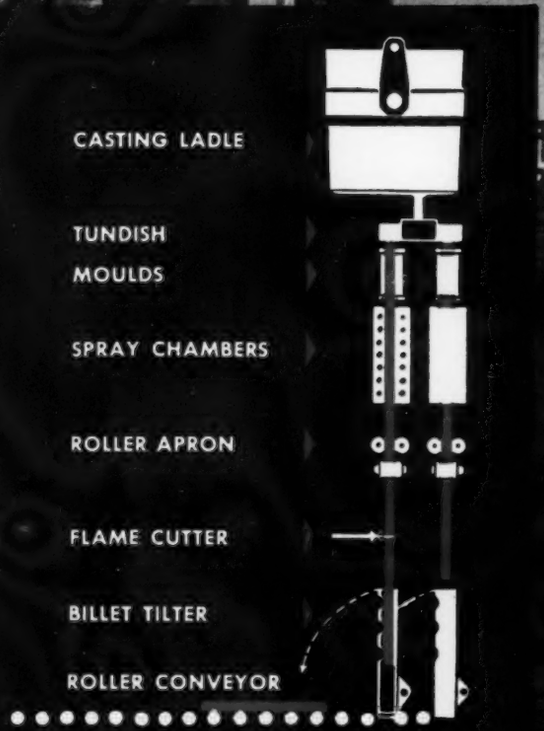

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Figure 4 (left) — Located on McKeller lake near Memphis, Tenn., this twin-boom coal unloader has a more functional appearance, lower cost and greater rigidity than conventional type unloaders.

Figure 5 (right) — Closeup of boom shows triangular cross frames and trusses, with supporting strut.

may adhere to the steel over a period of time, with resultant corrosion. The sealing effect of welding affords protection to such spots.

The cost of frequent paintings to arrest corrosion damage is no small item on these large units. Here again, the comparatively smooth surfaces of welded assemblies, with elimination of rivet heads, tends to reduce not only the frequency of painting but also the difficulties of cleaning the steel and applying the paint.

FABRICATION

In fabricating the twelve cross frames of the new unloader, a jig was used for assembly, since alinement of the track beams depends upon accurate in-to-in dimensions of the frames. Cross frame posts were handled as follows: after the component angles were straightened, ¼ in. was planed from the toe of each. Then the angles were welded together to form a channel approximately 11½ in. deep. The automatic submerged arc process was used, with a single pass on each side, assuring full penetration. Ends then were machine burned, welds ground smooth where gussets butted, and the top edge machined for a 60 degree bevel weld.

Each runway was shop assembled complete in three sections, with two splices in the truss. The walkway system spliced at the same locations as the track beam splices. The completed runway was shop assembled with tack welds and alined horizontally and vertically by sighting on the top of the rail. Vertical adjustments were made where the track beam welds to the bracket; whatever horizontal adjustment was required was afforded by placement of the rail chocks. Finally, the tack welds were removed and the three units shipped.

Material used throughout was ASTM-A7-55T structural steel, except for the ¼ in. liners in the hoppers. These are of Type 304 stainless steel.

ERECTION FEATURES

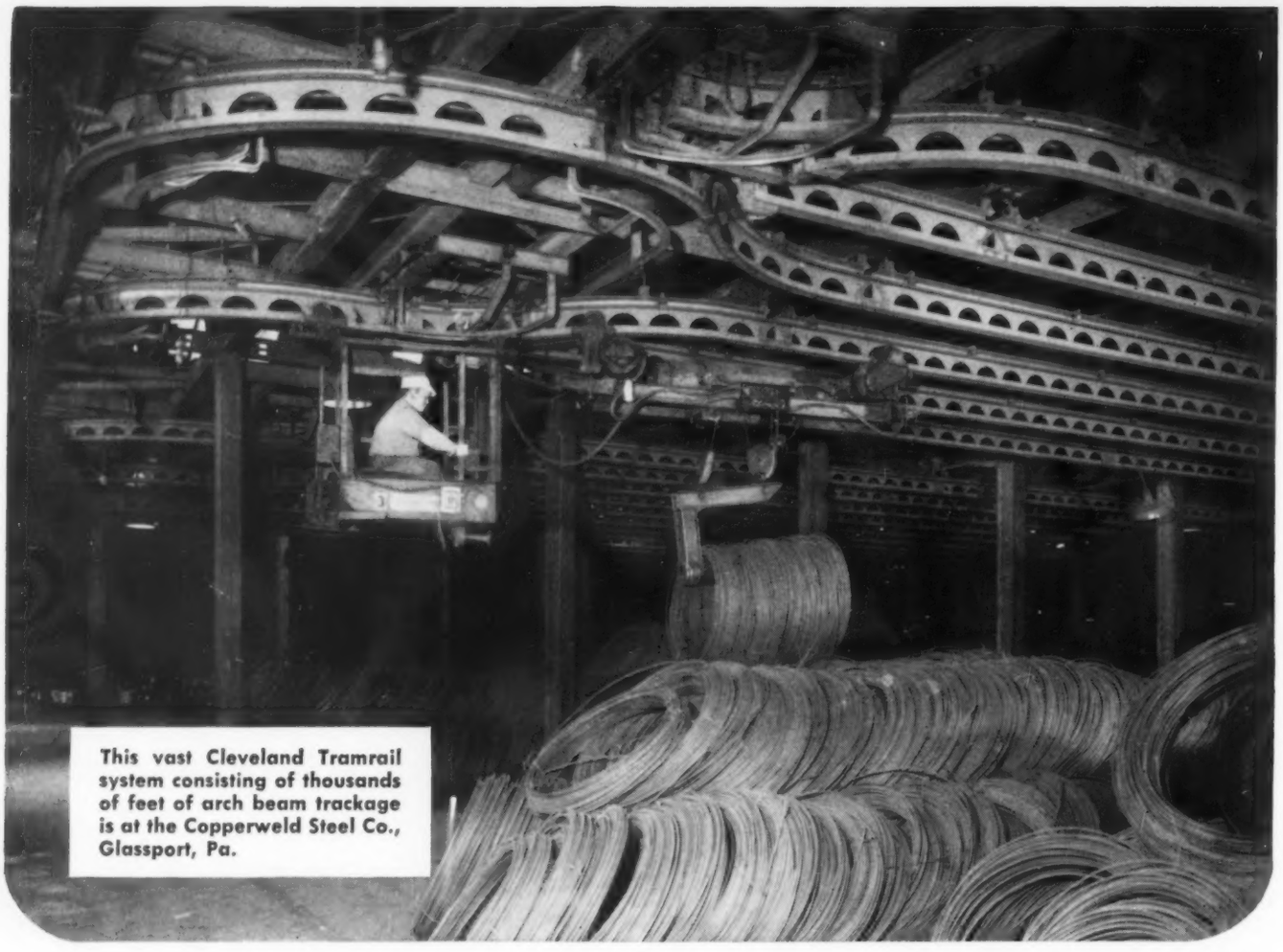
The unloader is erected on a steel sheet pile cell about 250 ft from the shore line of McKeller lake, located just southwest of Memphis. Steel placement began on July 16, 1958, using Dravo's C-24 derrick boat with a 175-ft boom.

In eight weeks time all the major steel was in place for the twin unloader, the derrick boat being released on September 5. The unloader went into operation on October 1, 2½ months after placement of first steel.

The value of the lower tower here proved itself. The top chord was only 147 ft above low water level, resulting in a much shorter lift than the 175 ft which a conventional mast-type unloader would have required.

Barge shipment from Dravo's Neville Island plant on the Ohio river directly to the site permitted large structural assemblies to be made in the shop. Hoppers, for example, were shop assembled in large units, with liner plates installed by means of welded studs projecting through clearance holes in the hopper plate. The operator's cab was shipped as a complete unit. All Galbestos sheeting was shop fabricated to shape.

All field joints were welded, with holes for erection bolts being provided for the main members. Light secondary members did not need such holes. Because of the larger shop assemblies, the number of field welds was held to a minimum and erection was acccomplished in record time. ▲



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Date-line Diary...

July 1

Δ The Material Handling Institute, Inc., index shows the dollar volume of orders for April, 1959 at 147.28, compared with 146.36 in March, 1959 and 122.36 in April, 1958 (using 100 as the monthly average for the statistical base year 1954).

Δ U. S. Dept. of Commerce, Bureau of the Census reported that shipments of iron and steel castings in March, 1959, amounted to 1,421,224 short tons, compared with 1,221,695 tons in February, 1959, and 953,509 tons in March, 1958; shipments in April, 1959, totaled 1,471,020 short tons compared with 948,879 tons in April, 1958.

Δ American Iron Ore Assn. reports shipments of iron ore down Lake Superior totaled 12,987,302 gross tons in June, 1959, compared with 8,040,973 in June, 1958.

July 2

Δ The Edison Electric Institute reported power output for the week of June 28 increased to 13,700,000,000 kwhr, 16.9 per cent above the year-earlier level.

Δ Auto production for the first half of 1959 totaled 3,284,037 cars, 46 per cent ahead of the same period in 1958.

Δ Steel scrap prices advanced $4 a ton in Pittsburgh, $1 in Chicago, with No. 1 heavy melting scrap selling at $40 a ton in Pittsburgh.

Δ The AISI reports that the operating rate of the steel industry for the week of July 6 is scheduled at 2,357,000 tons (83.2 per cent of capacity). This compares with 2,215,000 tons one week ago (78.2 per cent capacity), and 1,442,000 tons one year ago. Index of production for the week is 146.7.

Δ Southern Railway reported placing contracts totaling, $25,300,000 for 1240 cars, 1205 of which will have aluminum bodies; Santa Fe ordered 200 refrigerator cars, costing over $5,000,000, half of which will be built in its own shops.

Δ The Bureau of Mines reported that production of Pennsylvania anthracite for June, 1959, was 1,708,000 net tons compared with 1,388,000 net tons in May, 1959. Production for the first six months of 1959 totaled 9,858,000 net tons.

July 8

Δ Copper prices were reduced by U. S. custom smelters to 29½¢ a lb, down ½¢.

Δ In June, 1959, retail sales of automobiles totaled 580,500; deliveries for the first six months of 1959 amounted to 2,935,400, 33 per cent higher than the same period in 1958.

July 9

Δ USW rejected President Eisenhower's fresh plea for indefinite extension of steel labor contracts; industry seconded Mr. Eisenhower's motion for indefinite extension.

July 10

Δ The AISI reported that the iron and steel industry's payroll for 96.1 per cent of the industry for hourly and salaried employees totaled $396,914,755 in May, 1959, against $385,488,363 in April, 1959, and $257,965,765 in May, 1958. Average hourly payroll cost for wage earners was $3.346 in May against $3.340 in April, 1959, and $3.095 in May, 1958. Fringe benefits amounting to 33.2¢ per hr are not included. Employment during May, 1959, totaled 634,668, compared with 620,601 in April, 1959, and 500,369 in May, 1958; average hours worked per week in May was 39.9 compared with 40.7 in April, 1959, and 34.2 in May, 1958.

Δ The World Bank loaned $35,000,000 to Compagnie Miniere de l'Ogooue (COMILOG), for the development of high grade manganese deposits in the Gabon Republic, French Equatorial Africa.

Δ United Nations Economic Commission for Europe reports that Western Europe's steel output was down to 21,200,000 tons in the first quarter of 1959, or 2,000,000 tons below the same period in 1958.

July 13

Δ Steel producers rejected USW proposal which eliminated dispute over local working conditions aimed at averting a nationwide steel strike. Industry's chief negotiator, R. Conrad Cooper, told USW president David J. McDonald the industry was willing to participate in the union's proposed study of local work rules, but "an immediate extension of existing labor agreements is necessary if a shutdown of steel operations is to be avoided." The management spokesman declared the union had refused to accede to another contract extension.

Δ Spot copper in London continued to decline with present price at 26.31¢ a lb, comparable to American custom smelters' current quotation of 29½¢ per lb for refined copper and is 5.19¢ below U. S. producer price.

Δ The AISI reports that the operating rate of the steel industry for the week of July 13 is scheduled at 2,344,000 tons (82.8 per cent of capacity). This compares with 2,252,000 tons one week ago (79.5 per cent capacity), and 1,481,000 tons one year ago. Index of production for the week is 145.9.

Δ General Electric Co. reports net sales for the first six months of 1959 of $2,065,447,000, net income of $117,239,000 equal to $1.34 per share, compared with net sales of $1,978,994,000, net income of $103,381,000 or $1.18 per share, in the first half of 1958.

July 14

Δ Kennecott and Phelps Dodge reduced price of copper 1½¢ per lb to 30¢.

July 15

Δ The American Steel Warehouse Assn. reported that steel warehouse inventories total 3,700,000 tons; stocks are 1,000,000 tons greater than at the start of the 1956 steel strike, and show a 10 per cent increase since January 1, 1959.

Δ The Labor Dept. reported that employment surged to 67,300,000 in mid-June, up 4,600,000 since February; unemployment rose to 3,982,000 in mid-June, 593,000 above the mid-May total.

July 16

Δ Steel producers rejected USW proposal that the two sides set up a private union-industry fact-finding board to study issues involved in the current strike.

Δ Bureau of Statistics reported that Canadian steel mills operated at 91.9 per cent of rated capacity in the week ended July 11; output was 111,592 tons of ingots compared with 91,640 tons in the previous week.

July 17

Δ The Commerce Dept. reported that private housing starts in June, 1959, rose to a seasonally adjusted annual rate of 1,370,000, compared with a pace of 1,340,000 in May, 1959.

Δ Canadian steel ingot output for the first six months of 1959 totaled 2,768,435 net tons compared with 2,327,340 tons produced in the same period of 1958; production of pig iron for the first half of 1959 amounted to 2,016,105 tons compared with 1,593,498 tons in the first half of 1958.

July 20

Δ The Japan Iron and Steel Federation reports that production for April, 1959, totaled 730,000 metric tons of pig iron, 45,000 tons of ferroalloys, and 1,228,000 tons of ingot steel, compared with March production of 699,000 tons pig iron, 29,000 tons ferro alloys, and 1,218,000 tons ingot steel. For May, 1959, production totaled 795,000 tons pig iron, and 1,390,-000 tons ingot steel.

Δ The AISI reports that the operating rate of the steel industry for the week of July 20 is scheduled at 374,000 tons (13.2 per cent of capacity). This compares with 1,097,000 tons one week ago (38.7 per cent capacity) and 1,546,000 tons one year ago. Index of production for the week is 23.3.

July 21

Δ The Commerce Dept. reported that personal income rose to a seasonally adjusted annual rate of $382,900,000,000 in June, 1959, $1,600,000,000 above the May, 1959, level, and $31,000,000,000 over the June, 1958, rate.

Δ The ARCI reported that deliveries of new freight cars in June, 1959, totaled 3950 cars compared with 3358 in May, 1959, and 2407 in June, 1958. New orders for June, 1959, amounted to 8054 compared with 5253 in May, 1959, and 317 in June, 1958. Backlog of cars on order as of July 1, 1959, was 40,973 compared with 36,869 on June 1, 1959, and 27,757 on July 1, 1958.

Δ The Industrial Heating Equipment Assn. reported that new orders for industrial furnaces in June, 1959, were $7,029,269, compared with $3,672,000 in June, 1958; domestic orders for induction heating equipment for June, 1959, totaled $2,137,000. For the six months ended June 30, 1959, net new orders for industrial furnaces totaled $37,952,000, compared with $17,802,000 for the same period of 1958; for induction heating equipment, orders for the first six months of 1959 amounted to $7,415,000 compared with $2,915,000 for the same period in 1958.

July 22

Δ Labor Secretary Mitchell set himself up as a fact-finder in the steel strike, naming F. H. Mueller, newly-designed Secretary of Commerce and R. J. Saulnier, President Eisenhower's chief economic adviser, to assist him.

July 23

Δ The Aluminum Assn. reported that primary aluminum production in the United States during June, 1959, was 167,323 short tons compared with 163,857 short tons in May, 1959, and 115,325 short tons in June, 1958.

Δ Government figures showed that living costs increased ½ point to 124.5 per cent of the 1947–49 average in June, 1959.

July 24

Δ An official estimate issued by the President's Council of Economic Advisers showed the nation's output of goods and services rose to an annual rate of $483,500,000,000 in the second quarter of 1959, up $13,300,000,000 over the first quarter level.

Δ Allis-Chalmers Manufacturing Co. reported for the second quarter of 1959 sales of $137,101,357, net profit of $8,832,497 or 99¢ per share compared with the same period of 1958, sales $149,838,388, profit $8,216,013, or 75¢ a share; for the first half of 1959, sales were $221,226,490, net profit was $5,103,323 or 57¢ a share, compared with the same period of 1958, sales $269,506,611, net income of $8,399,788 or $1.02 per share.

July 27

Δ Auto sales by dealers in the second third of July, 1959, totaled 17,115 cars daily, 12.7 per cent above the early July rate and 30.6 per cent ahead of the like period of 1958.

Δ Government conciliators under Federal Mediator Joseph F. Finnegan will bring together the steel union and industry bargainers in their first joint meeting since the strike began.

Δ According to F. W. Dodge Corp. report, construction contracts in the U. S. excluding Alaska, in June, 1959, totaled $3,659,017,000, down 4 per cent from June, 1958.

Δ The AISI reports that the operating rate of the steel industry for the week of July 27 is scheduled at 362,000 tons (12.8 per cent of capacity). This compares with 365,000 tons one week ago (12.9 per cent capacity), and 1,561,000 tons one year ago. Index of production for the week is 22.5.

Δ The AISC reported that bookings of fabricated steel in June, 1959 totaled 290,911 tons compared with 241,612 tons in May, 1959, and 286,798 tons in June, 1958; shipments in June, 1959, totaled 365,434 tons compared with 294,127 tons, in May, 1959, and 329,240 tons in June, 1958. Backlog of future work as of June 30, totaled 1,717,098 tons.

July 29

Δ Aluminum producers and USW agreed to extend labor contracts slated to expire at midnight July 31, operations will continue under existing pact until 30 days after steel strike settlement.

Δ U. S. Steel Corp. promised to hold steel prices at present levels if a "voluntary settlement of the steel strike, no matter what it is" is reached.

Δ United Engineering and Foundry Co. reported for the first six months of 1959 a net profit of $3,270,307 equal to $1.29 a share compared with $2,726,739 equal to $1.10 per share for the same period of 1958.

July 30

Δ Westinghouse Electric Corp. reports for the second quarter of 1959 sales amounting to $474,132,000, net income of $19,741,000 or $1.12 a share compared with sales of $474,632,000, net income of $17,070,000 or 97¢ a common share. For the first half of 1959, sales reported amounted to $914,204,000, net income $34,150,000 or $1.92 a share, compared with sales totaled $923,961,000, net income $29,973,000 or $1.70 a common share in the first half of 1958.

Δ Arthur B. Homer, Bethlehem Steel Co. president, reported the possibility of steel price reductions if USW accede to changes in contract provisions governing working practices that would reduce operating costs.

Δ Machine tool orders in June, 1959, amounted to $67,300,000, 38 per cent above May, 1959, and

nearly double June, 1958; first six months of 1959 bookings totaled $305,000,000 compared with $179,000,000 in the first six months of 1958.

Δ American Iron Ore Assn. reports that the consumption of iron ore in the U. S. in June, 1959, totaled 11,131,356 gross tons; receipts of ore at iron and steel plants in the U. S. for June, 1959, totaled 17,762,875 gross tons; stock on hand on June 30, was 47,889,630 gross tons. Of 261 U. S. blast furnaces, some 217 were in operation on June 30, 1959, compared with 149 in operation on June 30, 1958.

Δ The AISI reported that the iron and steel industry's payroll for 96.1 per cent of the industry for hourly and salaried employees for the first six months of 1959 totaled $2,250,693,754 compared with $1,566,973,202 in the first half of 1958; the six month average employment in 1959 was 607,157 against 516,547 average in 1958's same period; average hourly payroll cost in the first six months of 1959 equaled $3.339 compared with $3.087 last year; average hours worked a week in 1959 averaged 40.4, against 34.3 in 1958.

Steel Companies Quarterly Financial Reports

	Period	1959 Net Sales	1959 Net Profits*	1959 Earnings per share	1958 Net Sales	1958 Net Profits*	1958 Earnings per share
Acme Steel Co.	2nd quar.	.....	$ 2,506,594	$0.91	$ 29,364,156	$ 1,137,369	$0.41
	1st half	$ 89,780,715	4,355,899	1.58	57,900,118	1,577,196	0.57
Alan Wood Steel Co.	2nd quar.	20,879,000	1,141,000	1.55	12,604,000	306,000	0.35
	1st half	39,329,000	2,096,000	2.84	25,210,000	339,000	0.31
Allegheny Ludlum Steel Corp.	2nd quar.	92,721,935	7,819,467	2.02	48,780,365	646,067	0.17
	1st half	162,998,022	12,369,009	3.20	99,235,290	1,371,967	0.36
Armco Steels, Ltd.	2nd quar.	338,249,251	29,441,030	1.99	219,474,943	11,626,179	0.79
	1st half	601,066,434	50,593,068	3.42	415,489,743	20,956,744	1.42
Atlas Steels Limited	2nd quar.	.....	800,000	0.74	.....	617,000	0.57
	1st half	.....	1,760,144	1.62	.....	908,820	0.84
Bethlehem Steel Co.	2nd quar.	832,216,538	73,591,528	1.59	506,049,384	29,003,419	0.61
	1st half	1,448,146,118	123,158,829	2.64	1,003,608,711	53,822,909	1.13
A. M. Byers Co.	3rd quar.	8,307,624	499,300	1.64	6,887,187	280,050	0.79
	9 mos.	19,763,399	994,700	2.98	17,046,218	366,300	0.56
Colorado Fuel and Iron Corp.	2nd quar.	.....	7,983,920	2.33	.....	1,063,388	0.27
	1st half	.....	12,588,760	3.51	.....	(326,708)	...
Continental Steel Corp.	2nd quar.	17,386,077	1,707,426	3.31	14,172,777	1,088,915	2.11
	1st half	30,318,806	2,788,457	5.40	23,428,625	1,669,754	3.23
Copperweld Steel Co.	2nd quar.	41,078,041	1,996,543	1.76	19,616,658	(94,633)	(0.12)
	1st half	74,554,175	3,497,798	3.08	40,433,967	(207,138)	(0.26)
Crucible Steel Co. of America	2nd quar.	88,083,827	5,109,855	1.31	41,255,709	226,932	0.06
	1st half	154,566,957	8,621,061	2.22	85,865,769	399,327	0.11
Detroit Steel Corp.	2nd quar.	32,962,021	3,023,921	1.00	13,649,027	1,839	(0.02)
	1st half	56,751,464	5,592,234	1.83	26,843,605	(301,839)	(0.14)
Eastern Stainless Steel Corp.	2nd quar.	20,288,421	950,137	0.66	11,904,494	684,226	0.48
	1st half	36,479,196	1,629,356	1.13	21,579,695	933,227	0.65
Granite City Steel Corp.	2nd quar.	47,634,634	4,838,563	2.26	28,543,003	1,839,401	0.86
	1st half	85,173,398	8,304,326	3.88	57,445,712	3,894,583	1.81
Inland Steel Co.	2nd quar.	257,289,594	24,313,291	1.40	159,904,283	12,118,584	0.71
	1st half	469,205,401	42,172,381	2.43	310,181,569	20,079,731	1.17
Interlake Iron Corp.	1st half	70,317,680	5,588,190	2.49	37,542,527	1,245,190	0.56
Jessop Steel Co.	1st half	.....	976,323	1.63	.....	274,206	0.48
Jones & Laughlin Steel Corp.	2nd quar.	316,384,000	26,468,000	3.34	156,215,000	4,034,000	0.47
	1st half	552,768,000	42,206,000	5.31	300,799,000	5,691,000	0.64
Kaiser Steel Corp.	2nd quar.	86,234,844	6,895,020	1.85	47,019,809	2,550,711	0.58
	1st half	147,264,817	10,197,707	2.61	93,313,054	4,600,137	1.02
Keystone Steel & Wire Co.	...	.....	....	...	.....	....	...
Lone Star Steel Co.	1st half	.....	6,338,902	1.78	23,359,657	482,829	0.14
Lukens Steel Co.	12 wks	27,734,742	2,063,181	2.16	26,717,371	1,587,179	1.66
	24 wks ending June 14	48,184,123	3,071,585	3.22	51,349,178	3,057,409	3.20
McLouth Steel Corp.	2nd quar.	.....	5,745,105	3.19	.....	1,892,800	0.84
	1st half	.....	10,657,133	5.90	.....	2,316,837	0.86
National Steel Corp.	2nd quar.	241,070,420	22,957,018	3.06	117,799,412	6,527,762	0.88
	1st half	438,730,125	39,461,108	5.26	231,288,194	10,329,188	1.39
Phoenix Steel Corp.**	2nd quar.	16,918,002	375,379	0.36	.....	....	...
	1st half	25,910,128	480,597	0.47	15,150,355	(1,060,431)	(1.02)
Pittsburgh Coke & Chemical Co.	2nd quar.	22,266,000	1,055,000	0.82	11,276,000	233,000	0.11
	1st half	37,861,000	1,721,000	1.30	21,541,000	443,000	0.20
Pittsburgh Steel Co.	2nd quar.	62,436,201	2,670,903	1.48	30,914,651	(563,778)	(0.56)
	1st half	113,734,377	4,041,518	2.14	63,027,163	(1,532,659)	(1.38)
Republic Steel Corp.	2nd quar.	464,528,425	40 245,132	2.57	228,433,654	15,321,096	0.98
	1st half	787,185,609	67,089,717	4.28	422,277,491	23,904,602	1.53
Sharon Steel Corp.	2nd quar.	48,866,113	2,480,052	2.24	20,820,505	(735,721)	...
	1st half	83,574,710	3,070,905	2.78	44,722,314	(1,018,934)	...
United States Steel Corp.	2nd quar.	1,448,743,088	148,363,193	2.64	863,067,790	73,224,051	1.25
	1st half	2,526,331,380	254,948,496	4.50	1,663,141,814	135,650,730	2.29
Universal Cyclops Steel Corp.	2nd quar.	37,557,816	3,228,688	1.92	18,628,017	723,025	0.43
	1st half	67,234,053	5,309,180	3.16	35,876,064	822,972	0.50
Washington Steel Corp.	9 mos.	.....	1,980,470	3.19	.....	382,568	0.59
Wheeling Steel Corp.	2nd quar.	89,757,000	6,540,000	3.16	57,152,000	2,464,000	1.05
	1st half	156,319,000	11,011,000	5.24	103,677,000	2,969,000	1.08
Woodward Iron Co.	1st half	.....	2,359,852	1.11	.....	1,739,902	0.82
Youngstown Sheet and Tube Co.	2nd quar.	244,274,952	17,162,941	4.94	124,183,526	4,236,641	1.23
	1st half	428,763,360	28,704,805	8.27	239,522,497	7,812,741	2.27

* Items in Parentheses are losses.
** Formerly Barium Steel Corp.

From mine through mill, LINK-BELT equipment

updates handling

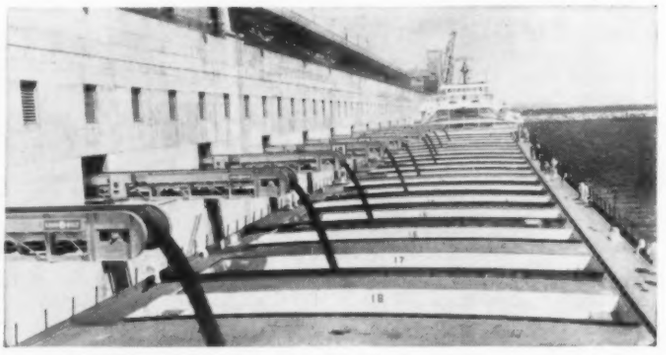
Moves higher tonnages at lowest cost in every phase of steel production

Raw materials must move swiftly and in huge volume to satisfy the enormous needs of the steel-making process. Link-Belt engineered systems take the slack out of steel production by linking the many phases of materials handling into a coordinated, economical operation.

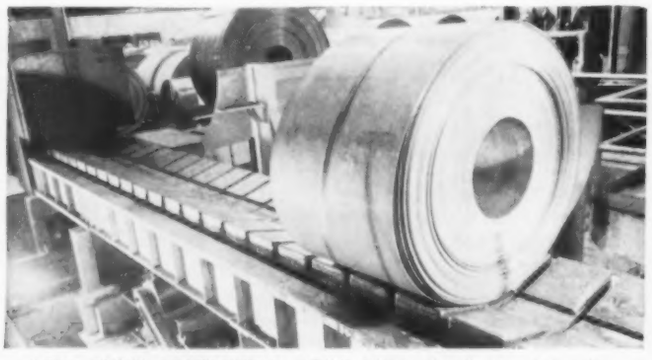
All the way through the mill Link-Belt equipment handles the rough, tough jobs. Conveyor systems move and transfer heavy coils—safely. Chain conveyors transfer white hot billets. Hot slabs, sheets, plate and other items move efficiently from one process to another. Link-Belt engineers will work with your engineers, consultants and builders of mill and process equipment to update your handling procedures. Call your nearby Link-Belt office for information and send for Book 2764. Motion picture available too. Ask to see 16 mm. sound, color film, HANDLING MATERIALS IN THE STEEL INDUSTRY. It shows equipment for handling raw materials and steel coils through various processing operations to final shipment.

WORLD'S LARGEST traveling belt conveyor stacker built by Link-Belt for stockpiling taconite pellets. The huge, self-propelled stacker measures 416-ft. from tip of belt boom to end of counterweight boom. The 275-ft. belt boom stockpiles to a height of 90-ft. Principally for winter operations, the stacker is designed to operate at temperatures of 45 degrees below zero, and winds of 68 mph.

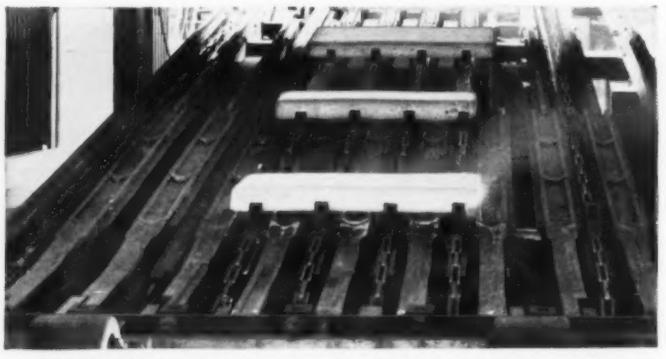
FROM THE MINE—Belt conveyors and traveling belt conveyor stackers stockpile 1000 tons of graded ore per hour. High grade ores are blended with low grade ores to blast furnace requirements. Ore is then shipped to the mills.



TACONITE PELLETS are loaded into Great Lakes steamer by ten Link-Belt shuttle belt conveyors. Two-speed shuttles permit loading at 1500 or 750 g.t.p.h. Conveyors are pushbutton operated by one man in the control tower.

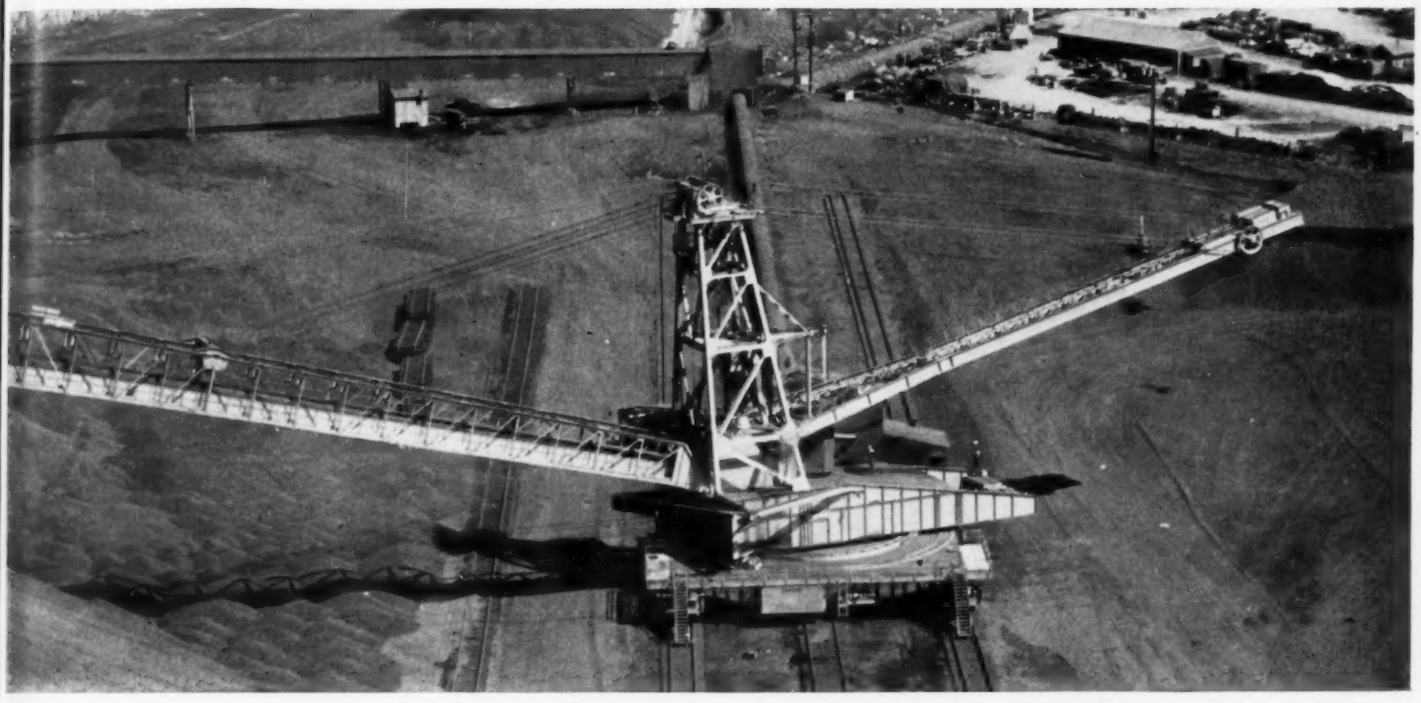


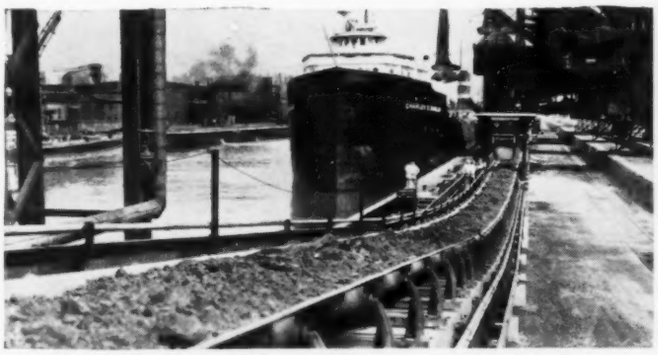
COILS FROM CONTINUOUS PICKLE LINE, ahead of cold rolling mill, move on a V-top, 36-in. wide, heavy-duty pallet conveyor. Each coil weighs 15 tons . . . is carried on its side without scuffing or damage.



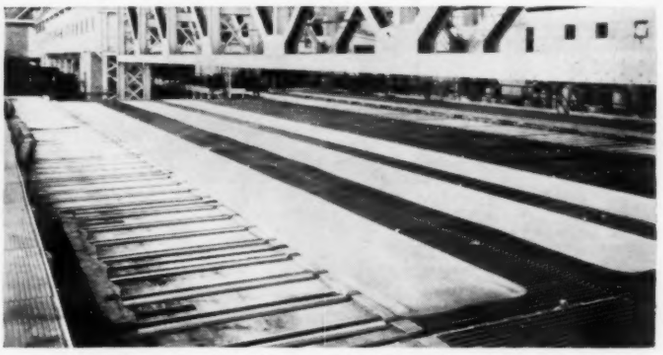
WHITE HOT SLABS are transferred from slabbing mill delivery table to outside storage yard. This heavy-duty, 12-in. pitch, multiple strand chain conveyor assures continuous movement of slabs to match production . . . cooling them in route.

to undercut costs

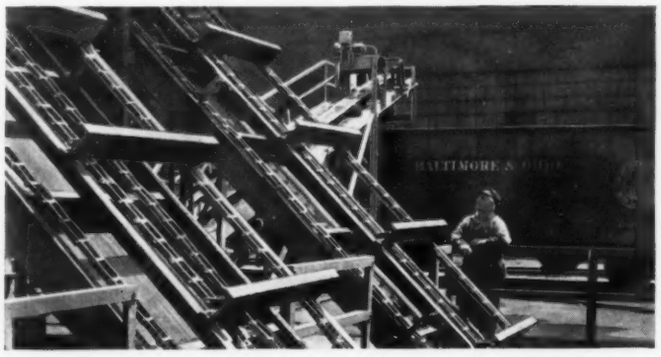




FROM SHIPS TO STORAGE or screen house—6000 tph belt conveyor keeps raw materials flowing the year around in all kinds of weather. Materials discharge from apron feeder to 60-in. wide, 1260-ft. conveyor on first leg of mile-long trip.



HOT STRIP at this 98-inch hot mill is transferred laterally from run-out table by 51 strands of Link-Belt chain with special pusher dogs. Seventeen strands are used to advance the strip across each of three sections of transfer table.



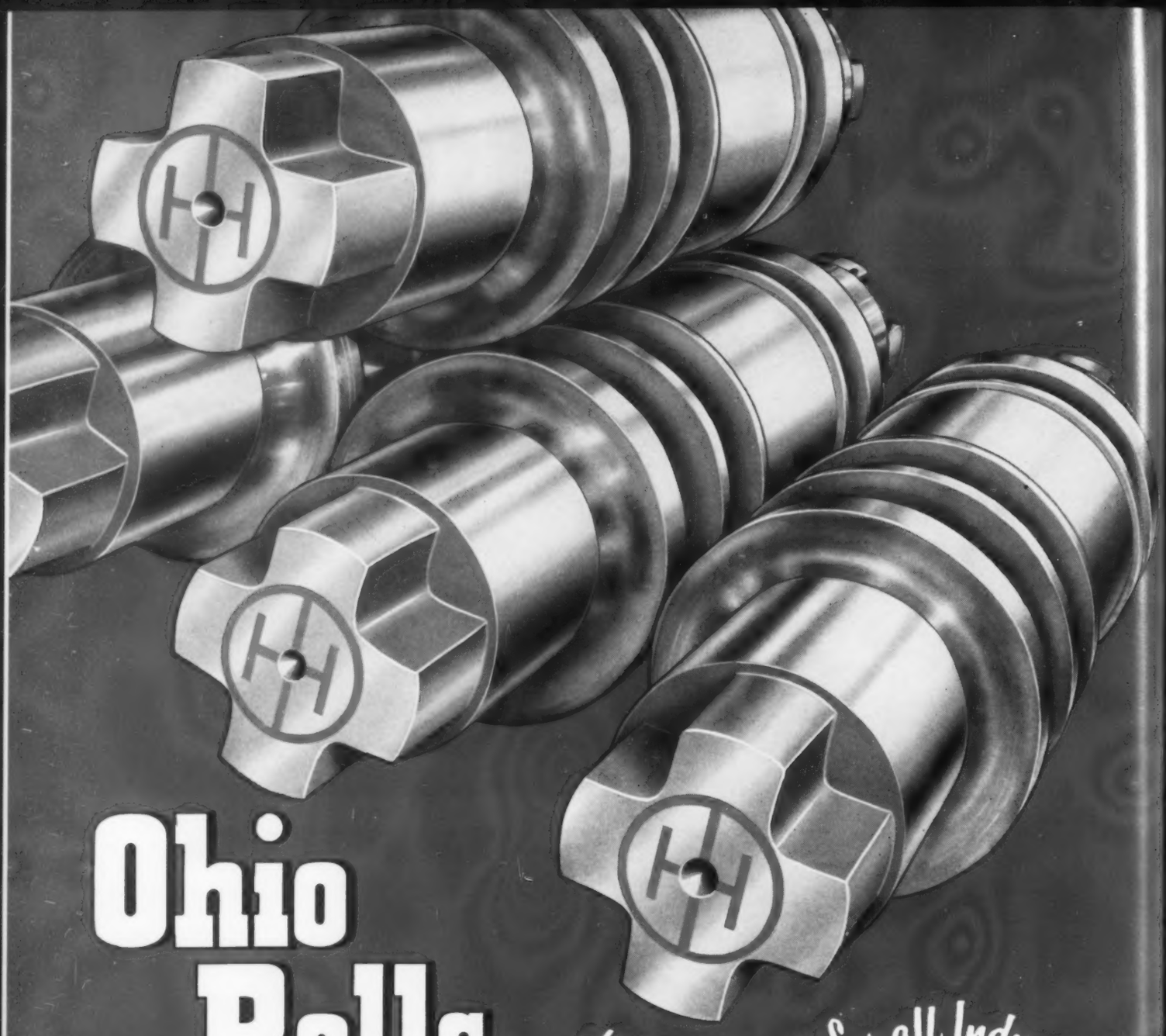
MILL SCALE is carried off by three Link-Belt Straightline collectors, after it is sluiced from hot strip mill to concentrator. Two Link-Belt conveyors, horizontal collecting belt and inclined pivoted loader carry scale to rail cars.

LINK-BELT

MATERIALS HANDLING, PROCESSING & POWER TRANSMISSION EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World.

15,252



Ohio Rolls

shaping metal for all Industry

OHIO IRON AND STEEL ROLLS

Carbon Steel Rolls
Ohioloy Rolls
Ohioloy "K" Rolls
Nioloy Rolls
Flintuff Rolls
Double-Pour Rolls
Chilled Iron Rolls
Forged Steel Rolls
Denso Iron Rolls
Nickel Grain Rolls
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The Ohio Steel Foundry Co.

LIMA, OHIO

LIMA... Virtually at the center of the steel industry

PLANTS AT LIMA AND SPRINGFIELD, OHIO

0831

Industry News...

ADDITIONAL EXPANSION PROGRAM ANNOUNCED BY GRANITE CITY TO INCREASE STEELMAKING

Δ The Granite City Steel Co. has begun another expansion program to raise its annual steelmaking capacity an additional 10 per cent to a total of 1,740,000 tons, Nicholas P. Veeder, chairman of the board and president has announced.

Major construction will be completed by the end of 1961, Mr. Veeder said. It will include the replacement of one of the Company's two blast furnaces with a new furnace able to produce twice as much pig iron; structural and design changes and more use of oxygen in seven steelmaking open hearth furnaces; further improvements in the cold rolling department; and the installation of a second continuous galvanizing line and a second electrolytic tinplate line. Construction of the new tinplate line has already started.

Granite City's rated capacity is now 1,440,000 tons a year. The effects on open hearth production of facilities built during the present expansion program, which began in 1956, will bring the capacity to 1,584,000 tons by the end of this year.

The construction that will boost open hearth furnace capacity will consist of improvements to enable the open hearth furnaces to produce a given amount of steel in a shorter time.

One will be a larger supply of molten pig iron. The new blast furnace will have a 28-ft hearth diameter and be able to produce 1800 tons of pig iron a day, double the capacity of the old furnace it will replace. Construction by Koppers Co., Inc., will begin this fall. Combined with a newer blast furnace, built three years ago, this will raise Granite City's total daily pig iron capacity to 3000 tons, or 1,100,000 tons a year.

Open hearth capacity will also increase due to structural and design changes in the furnaces themselves. The conventional silica brick roofs of the open hearths are being replaced with advanced forms of basic brick to withstand the higher operating temperatures that result from the use of oxygen. Three furnaces have already been equipped with water-cooled roof lances through which oxygen is jetted onto the molten steel bath to speed up the oxidation and removal of impurities. Lances will be installed in the roofs of other furnaces.

Already completed is most of the foundation work and the structural framework for the building that will house a 277-ft-long electrolytic tinplate line, scheduled to go into production early next year. It will be able to produce 12,000 tons of tinplate a month.

The second continuous galvanizing line will not be completed until late in 1961. At present, Granite City operates four hot-dip pot lines and one continuous line. The new facilities will enable the company to broaden its line of galvanized products. Production on the present continuous galvanizing line was increased early this year by improvements to some sections of the 348-ft-long unit.

TINPLATE FACILITIES EXPANDED AT WEIRTON

Δ Two electrolytic tin-plating lines and two continuous annealing lines were recently installed and are now in operation, at the Steubenville, Ohio, plant of Weirton Steel Co.

The equipment was purchased from Crown Cork and Seal Co., Inc. of Baltimore, Md., and was rebuilt

SMOKE HOODS AID SCARFING AT TIMKEN

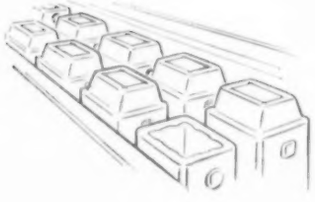
Hot scarfing stations processing high and medium carbon steels at Timken Roller Bearing Co.'s Steel and Tube Division are being equipped with "smoke hoods" that effectively collect smoke at the source. The device, developed by steel mill personnel was installed to improve working conditions. The rounded metal shield covers the blooms being hot scarfed without obstructing the scarfer in his work. An exhaust fan with a capacity of 40,000 cfm withdraws air from one end of the hood. The air channels through the hood taking all smoke and dirt away from the work directly into the smoke collection system serving the entire area. Since none is dissipated into the air, there is much less smoke in the Bloom Conditioning Department. A cable and drum powered by an electric motor raises and lowers the hood in seconds. The scarfer controls it from his work station. With the hood in the "up" position lift trucks can stock the feed racks for the scarfer. No production was sacrificed by the installation of the hood nor was any change in scarfing procedure necessary.

GREATEST SINGLE ADVANCE IN HOT TOP PRACTICE

HOT TOP MOLDIT CASTABLE REFRACTORY

for poured monolithic hot top linings

■ ***Exceptional insulating value***
permits reduction of hot top volume. In one plant, brick-lined hot tops had a volume of 14%. When relined with HOT TOP MOLDIT castable, volume was reduced to 12%. Yield of semi-finished, non-hot scarfed steel rose from 79.3% to 81.5%.



■ ***Far outlasts brick linings***
In one case, brick-lined hot tops had an average service life of 47.3 pours with a 15% hot top volume. HOT TOP MOLDIT linings had average service life of 79.6 pours with a 13% hot top volume.

■ ***Easily adaptable to die design change***
No trouble and delays as with firebrick linings. Mix HOT TOP MOLDIT with water and cast hot top lining right on the job.

■ ***Non-Wetting Properties***
Little, if any, parting compound required. Little chance of inclusions caused by parting compound falling into ingot mold.

REFRACTORY & INSULATION CORP.

REFRACTORY BONDING AND CASTABLE CEMENTS
INSULATING BLOCK, BLANKETS AND CEMENTS

136 Wall St., New York 5, N. Y.

and modernized by Weirton Steel construction and maintenance personnel.

The new lines can handle coils 32 in. wide and 64 in. in diameter, weighing up to 20,000 lb, at a speed of 600 fpm. This increased capacity of the lines was made possible by repowering some units, adding new reels to handle larger coils, and adding larger looping towers to provide greater speed. New heating furnaces were also added to the continuous annealing lines. Two reflowing units have been added to the plating lines, which lines are now completely modern as far as pre-reflow and post-reflow treatment is concerned.

The plating lines are the alkaline vertical type. In the vertical plater, the steel strip is completely immersed in a caustic plating solution.

When installation of the new lines began, the Steubenville plant was a hot dip tinplate and black plate producer with a monthly capacity of 24,000 tons of tinplate and 5000 tons of black plate which was used for all types of containers.

Sixteen tin pots were removed to make room for the two electrolytic tinning lines, which have a capacity of 18,000 tons per month. Ten tin pots continue in operation. There is a monthly capacity of 9000 tons of hot dip tin plate and 3000 tons of black plate.

Annealing was formerly done at the plant by the portable box batch process; but with advanced techniques in the industry this is being replaced by continuous coil type annealing. The annealing lines have a monthly capacity of 21,000 tons. The plant also has box type annealing capacity of 10,000 tons per month.

McDONALD WORKS TO ADD NEW COIL WELDING LINE

△ The Youngstown District Works of United States Steel Corp. has placed contracts for construction of a new coil welding line at the No. 18 hot strip mill in the McDonald, Ohio, plant. With the new mill in operation, coils weighing 30,000 lb will be produced.

E. W. Bliss Co. will be the principal contractor and McKay Machine Co. will supply several major pieces of equipment.

Equipment to be installed for the new coil welding line will consist of

an electric flash welder, a processing uncoiler, x-ray thickness gage, new shear, a flash and weld trimmer, a recoiler and several automatic handling machines. The new line will also be equipped with an oiling device in order to furnish customers with an oiled strip product as required.

The equipment will be housed in a new building to be constructed by the corporation's American Bridge Division.

Construction will begin early in 1960 and will be completed in the same year.

INLAND TEMPER MILL HAS RAPID RESPONSE

△ A rapid speed two-stand, 54-in. temper mill which is being installed by Inland Steel Co. at Indiana Harbor Works, features all static excitation and amplification, including 60 and 400-cycle amplifiers. This will make possible very rapid speed response in the 7000-ft a minute steel strip processing operation.

Key electrical equipment for this mill is being furnished by Allis-Chalmers Manufacturing Co. It consists of main drive motors, motor-generator set, variable voltage control, switchgear, and a 1000-kw mercury arc rectifier. Direct current motors include two 1500-hp units for stand drive, two 1000-hp machines for tension rolls, a 1000-hp unit for the delivery reel and two 500-hp units for the entry reel. Motor-generator equipment includes two 1250-kw and four 1000-kw d-c generators and a 5500-hp synchronous drive motor.

CONTRACTS AWARDED BY NATIONAL STEEL

△ Contracts have been let for electrical equipment of the 80-in. continuous hot strip mill and for an additional oxygen plant in the current $300,000,000 expansion program of National Steel Corp.

The 80-in. mill will be installed at Great Lakes Steel Corp. The new mill will have a rated capacity of 3,600,000 tons of steel coils per year. The contract for the mill's finishing stand electrical equipment has been awarded to General Electric Co. The contract for electrical equipment on the remainder of the mill

35% NICKEL

DURALOY

15% CHROMIUM

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Here are two good examples of our work in high-nickel castings!

These are in the Duraloy HT group calling for Ni 33.37 percent. We've gone as high as 68% nickel on some castings where extremely high temperatures and very severe corrosive conditions had to be resisted. The important factor concerning castings for exceptionally high temperatures is that they must retain their structural form under load.

Knowing just how much nickel to put in and how much chromium and other alloying elements depends to a large extent on experience . . . and it is experience that we can offer you for the castings you need. We've been producing static castings since 1922 and centrifugal castings since 1933, being among the pioneer founders in each class.

If you would care to have our metallurgist study your casting problem, we shall be glad to have you call upon us for the service.

Our New General Catalog is yours for the asking.

HIGH ALLOY CASTINGS

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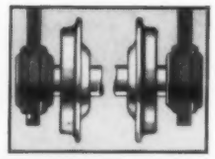
built to last by a company that uses them!

5 unique structural features make them better

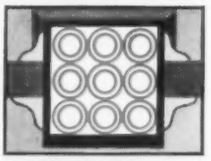
Ingot Mold Cars take more punishment than perhaps any other cars in a modern steel plant. In the 36 years we have been making these cars for our own use, United States Steel has developed a number of features in structural design that assure longer life, less maintenance, and dependable service.

Shown here is a typical 8-wheel, 200-ton capacity Ingot Mold Car. The advantages illustrated at the right—plus the rugged durability of all-welded rolled-steel construction—make any size USS Ingot Mold Car a profitable investment.

Our representative will be pleased to call at your convenience to discuss your requirements for this or any other type of industrial car. For more information, write to United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania. *USS is a registered trademark*

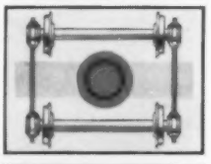


Anti-friction outboard bearings: High-capacity anti-friction bearings are located *outside* each of the car's eight wheels to minimize sidesway and to provide long, smooth-running performance.



Seventy-two coil springs: Nine coil springs between each two wheels on both sides of the car—plus nine overload coils *inside* these—provide a total of 72 separate springs for a shock-absorbed *level* ride, so important in hauling molten metal.

High engineering safety factor: Designed for a 200-ton normal capacity load—including ingots, molds and stools—each car has a substantial built-in safety factor to withstand maximum ingot-stripping thrusts.



Oversize center plates: "Beefed-up" center plates between the trucks and car body are 18 inches in diameter—compared with the conventional 12 inches—to reduce the load per square inch on their surfaces.

Hot-metal shields: Curved end plates, long side skirts, and special drip shields protect the couplers, bearings and springs from runover molten metal and troublesome solidified drippings.

USS

United States Steel Corporation — Pittsburgh
Columbia-Geneva Steel — San Francisco
Tennessee Coal & Iron — Fairfield, Alabama
United States Steel Export Company

United States Steel

and all auxiliary facilities has been received by Westinghouse Electric Corp.

Air Products Co. has been awarded the contract to construct a high purity oxygen plant at Weirton Steel Co. The plant will have a capacity of 650 tons per day and will be the largest oxygen installation for a single steel plant in the United States. Its output will be used primarily to increase steel production in open hearth furnaces.

National Steel's expansion program will be completed over the next three years. In addition to the 80-in. strip mill and the oxygen plant, the program will include the construction of the Midwest Steel Corp. finishing plant in northern Ind.; the addition of 500,000 annual tons of ingot capacity at Great Lakes Steel Corp., and improvements and additions to tin plate and cold rolled sheet facilities at Weirton.

MIDDLETOWN TO INSTALL NEW ZINC COATING UNIT

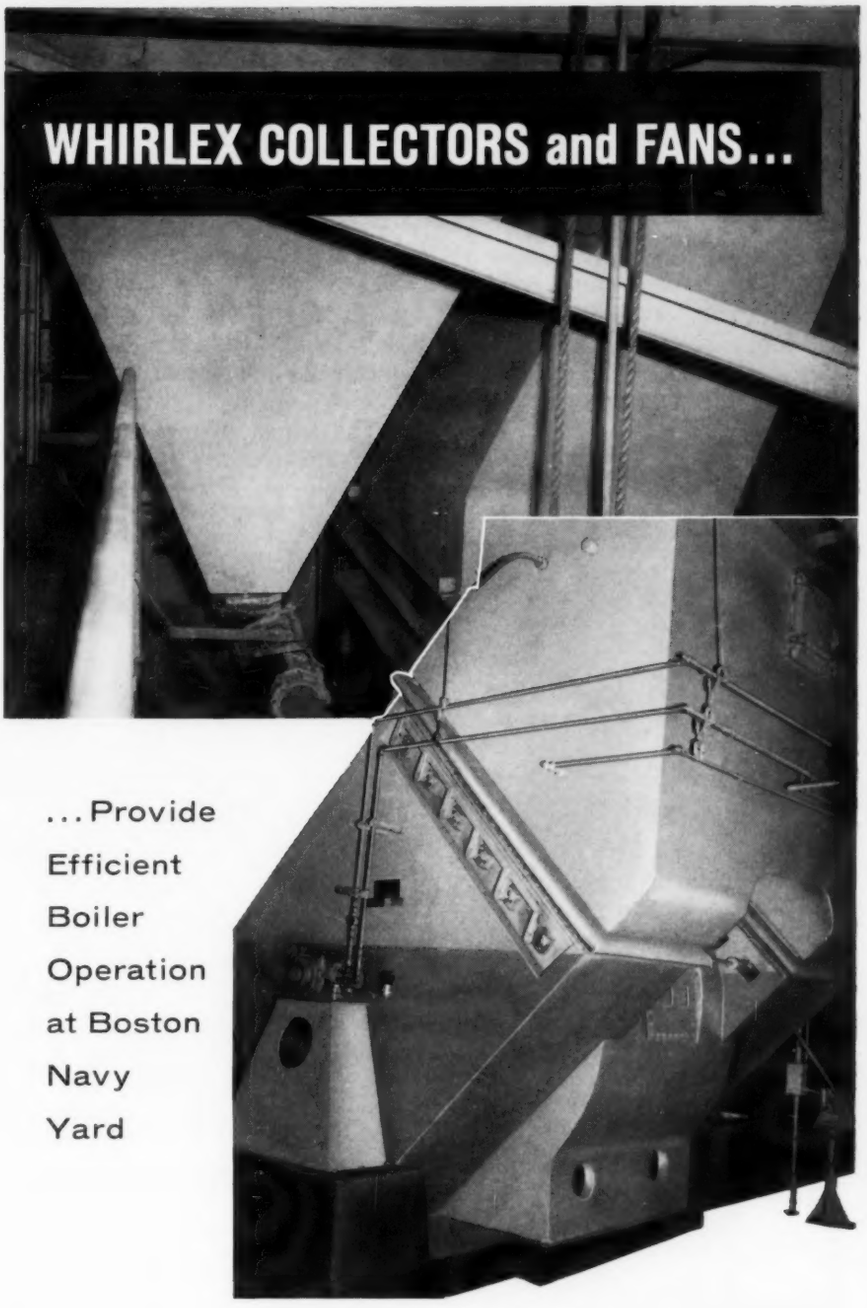
△ A continuous coating unit for the production of zinc-coated steel sheets will be installed at the Middletown Works of Armco Steel Corp.

Clyde G. Davies, vice president—operations, Armco Division, said that associated with this new facility will be a conversion of one of the existing zinc coating units at Middletown for the production of aluminum-coated sheets and coils. The design of the new line also will provide for the addition of aluminizing equipment at some later date.

The new 565-ft long production line will practically double the Middletown's capacity to produce coated grades of sheet and strip. It will also be a substantial addition to Armco's total coating capacity.

A contract has been awarded to The Wean Engineering Co., Inc., for construction of the new unit and work will begin as soon as possible. The unit is scheduled to be in operation by the end of 1960.

Armco's coated steels are hot-dip coated with molten zinc or aluminum by a continuous, high-speed process which was developed and patented by the company. The new unit will incorporate the latest improvements in the Armco process. It will be able to coat



The WHIRLEX collector and fan shown here are part of an integral system installed at the Boston Navy Yard. The unit is designed to carry hot gases and is complete with a re-injection system. The Whirlex custom built fan is designed to absorb thermal expansion in any direction and features water cooled bearings and built-in inlet damper controls.

Complete information on this and other WHIRLEX installations is available to you at your request.

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Dust Collectors · Induced Draft Fans · Forced Draft Fans
Exhaust Fans · Self Supporting Stacks · Duct Work

WHIRLEX

72-in. wide steel strip at a speed of 300 fpm. Capacity of the new line will be approximately 30 tons of coated steel an hour.

CF&I ANNOUNCES PUEBLO MODERNIZING PROGRAM

△ The Colorado Fuel and Iron Corp. plans a $16,600,000 expansion, diversification and modernization program at Pueblo, Colo.

An oxygen steel converter with a capacity of 50,000 ingot tons per month will be installed.

In addition, a heavy-duty cooling bed will be installed at the 25-in. mill to increase plant capacity and efficiency in the production of structural steel and in rolling billets, tube rounds, and similar sections. The cooling bed is expected to increase the structural section capacity by about 132,000 tons a year.

Also, improvements are scheduled in the mechanical and functional operation of the 14-in. mill. The improvements are expected to increase the mill's capacity by 12,000 tons of product per year.

The wire mill capacity for high carbon wire and wire products will also be increased about 11,000 tons per year.

CF&I will also add at Pueblo new facilities for the manufacture of welded wire fabric. Other improvements are scheduled for the Pueblo rod mill.

Additional power facilities are also to be installed, including a 69,000 volt loop transmission and distribution system.

BIRDSBORO AWARDED MEXICAN MILL CONTRACT

△ A contract for a complete new steel rolling mill has been awarded Birdsboro Steel Foundry & Machine Co., by Altos Hornos de Mexico, S. A., of Monclova, Mexico.

The equipment, first of its type in Mexico, is a single stand 22 in. two-high reversing mill for rolling 8 in. x 8 in. and 6 in. x 6 in. mild steel blooms into 4 in., 3 in., 2½ in., and 2 in. billets. Delivery is scheduled for the end of 1959.

This will be the first complete mill installation ever made by Birdsboro in Mexico. The new mill is equipped to roll billets for subsequent conversion into rods, merchant bars, reinforcing bars and light structural shapes.

LINDE TO BUILD GREAT LAKES OXYGEN PLANT

△ Linde Co., division of Union Carbide Corp., will build a 500-ton-a-day oxygen plant at Great Lakes Steel Corp.

Four smaller oxygen plants, with a combined capacity of 100 tons a day, have been in use at Great Lakes Steel for several years. However, plans to add oxygen to the open-hearth furnaces by roof lances have created an expanded need for oxygen. Approximately 80 per cent of the oxygen produced will be used in the open-hearth to improve and speed the steel melting process; 10 per cent will be used for mechanized scarfing. The remainder will supply other finishing processes and general maintenance requirements.

The plant will be capable of producing 365 million cu ft of high purity oxygen a month.

Linde's nationwide distribution system for liquid oxygen will be employed by Great Lakes when the plant is shut down for maintenance and for their requirements in excess of the on-site plant's capacity.

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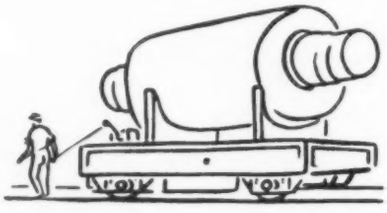
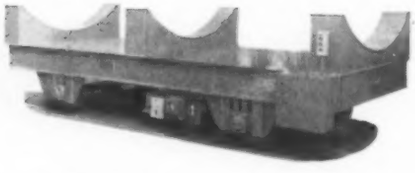
for

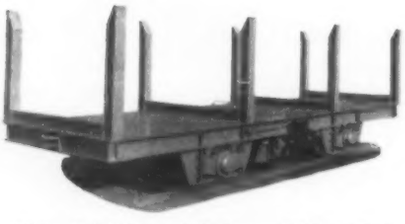
payload

efficiency





20-Ton Storage Battery with Cradle for Pipe



40-Ton Safety-Type Walk-Along with Stake Bed

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- *SAFE — because one lever controls forward-reverse-stop.*
- *SAFE — because car stops when operator releases lever.*

Atlas transfer equipment is designed for your specific load and production needs. Optional power includes Storage Battery (Walk-Along or Rider-Type) • Gas-Electric • Diesel-Electric • Cable Reel AC • Cable Reel DC • Cable Reel AC With Fluid Coupling • also remotely controlled cars without trailing cable.

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The Wean Engineering Company worked in close cooperation with the Wheeling Steel research department on the development, design, and construction of these lines at the Martins Ferry plant. The lines are currently producing a wide range of top quality galvanized sheets and coils at speeds up to 300 fpm.

Wean has designed and built galvanizing lines for a wide variety of customer requirements. Why not take advantage of Wean's *creative engineering* experience on your next coating line project.

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LONGEST LIFE UNDER TOUGHEST CONDITIONS

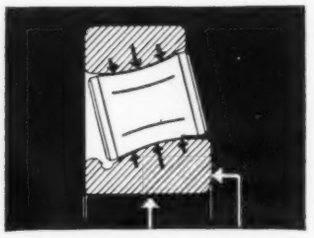
With Shafer Self-Aligning Roller Bearings your equipment lasts longer under tough conditions that usually spell early trouble.

You eliminate many hours of costly down time and keep maintenance costs at a minimum... you get the very best in dependable service.

The reason: Shafer Self-Aligning Roller Bearings maintain their high load-carrying capacity and long life under any type of load. Here's why:

Shaft deflection

Under misalignment due to shaft deflection (a total of 3°), Shafer design allows full freedom of action without extra wear.



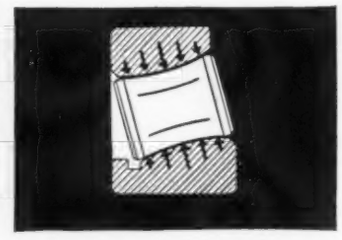
Radial, thrust or combined loads

Due to Shafer concave-roller, convex-race design, all loads remain safely centered on tough load-bearing surfaces. Because of self-centering rollers, there's no need for guide flanges at roller ends.

Shock Loads

Shafer design combines the low-rolling friction of a ball with the high load and shock capacity of a roller. The elasticity of Shafer rollers and raceways permits compression under shock. The contact area increases to fit the load-bearing area to the load requirement.

Under Normal Load



Under Heavy Load and Shock

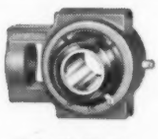
Pillow Blocks

Flange Units

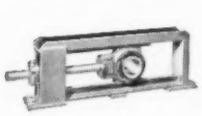
Flange Cartridge Units

Cartridge Units

Duplex Units



Take-Up Blocks



Take-Ups

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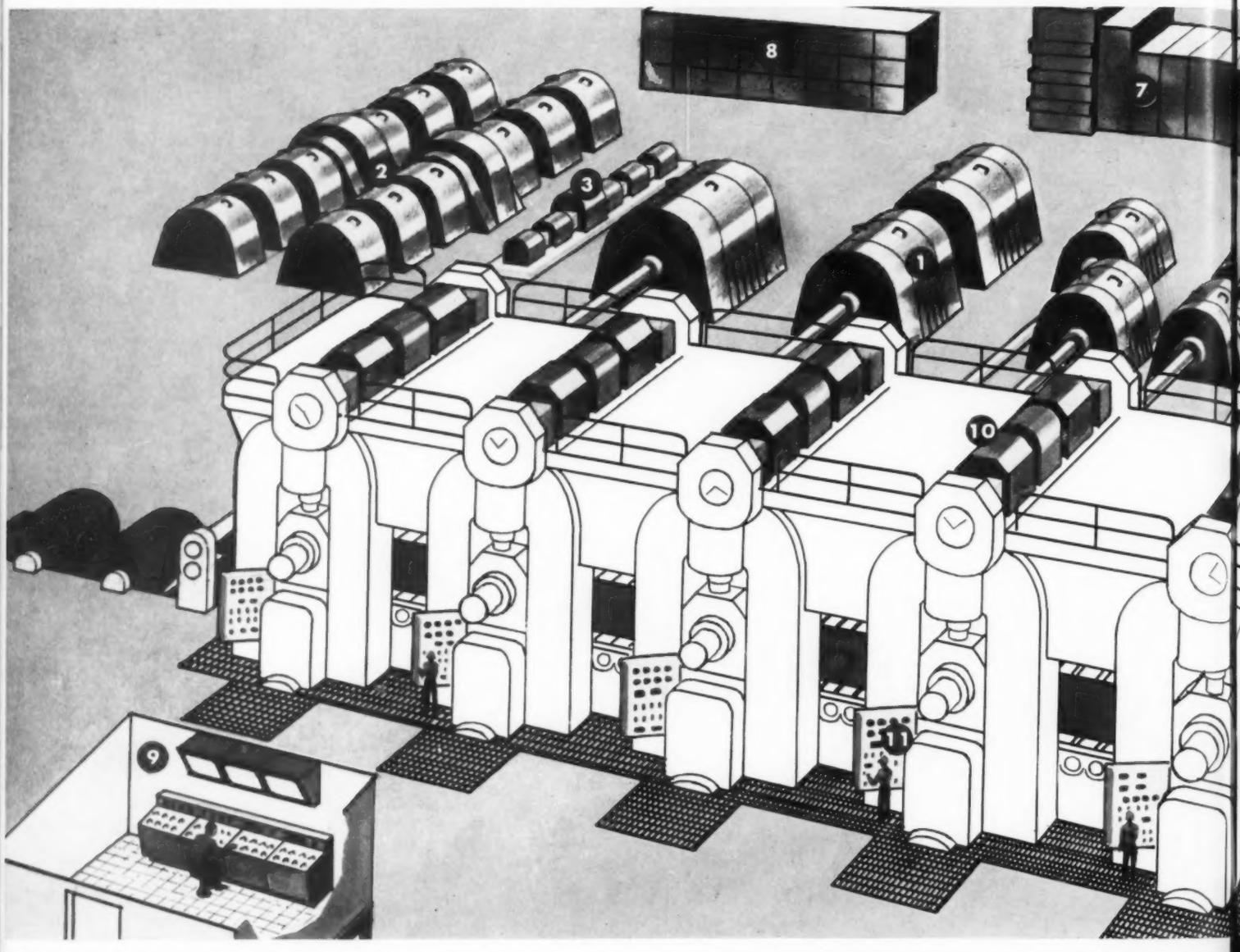
INCREASE YIELD, MODERNIZE FOR PROFITS



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3. **Auxiliary m-g sets** provide precise d-c power to screw down motors.
4. **Main mill control** utilizes most modern control techniques for maximum reliability while performing the complex functions of automation.
5. **Automatic gage control** using quick-response DIRECTO-MATIC static control and RAYMIKE 600 X-ray thickness gage combines extreme accuracy with great reliability over long periods.
6. **G-E 309 data logger** keeps accurate record of gage. Records all production information important to business functions of the mill.
7. **Load center** assures reliable secondary distribution of d-c power, at the desired voltage level, to all points-of-use in mill.
8. **Metal-clad switchgear** combines maximum reliability and safety with minimum of maintenance in distribution of power to all mill functions.
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10. **MD-600 motors** drive stand screwdowns, provide instant response and minimum of maintenance to most vital mill function.
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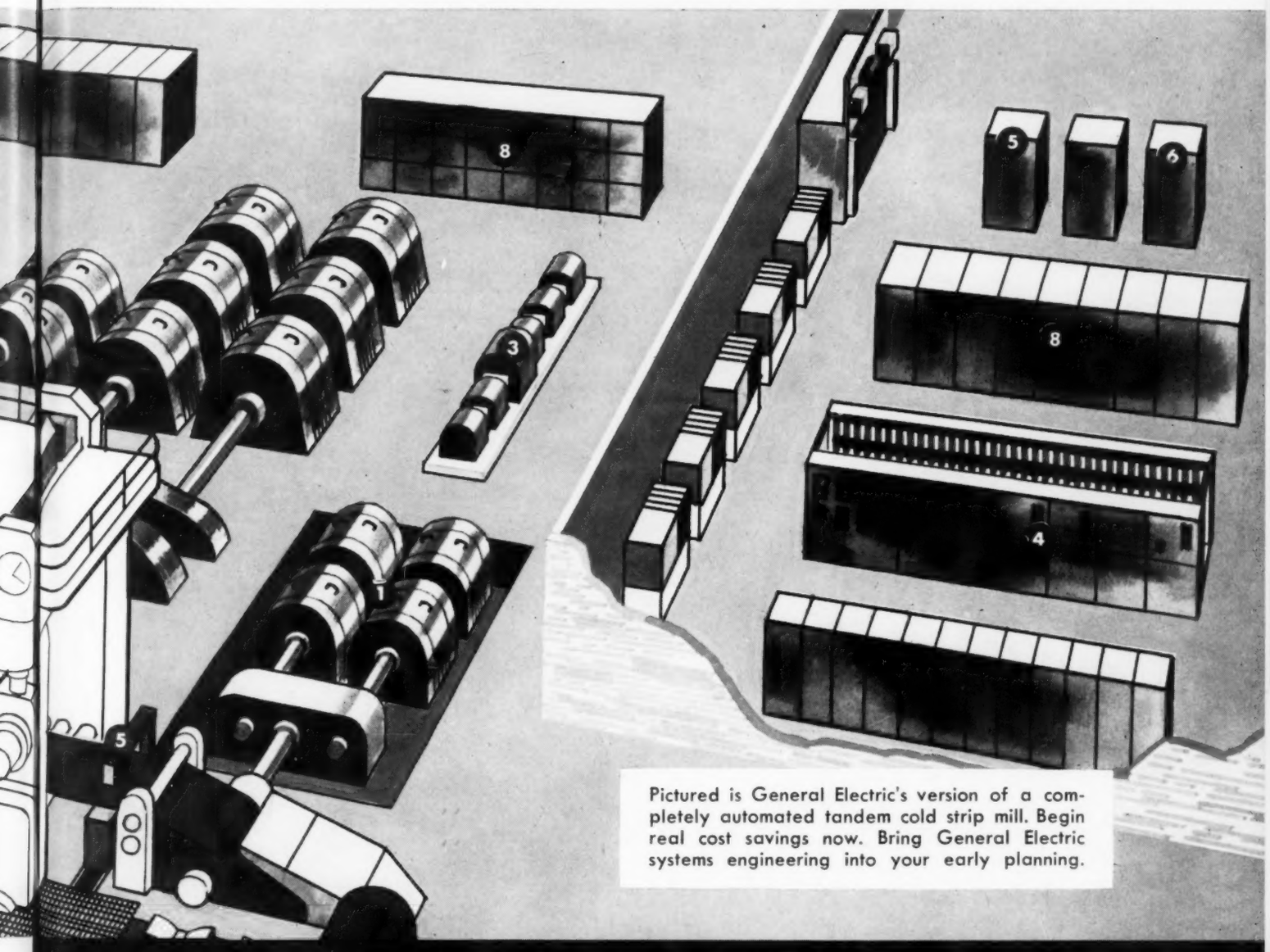

Pictured is General Electric's version of a completely automated tandem cold strip mill. Begin real cost savings now. Bring General Electric systems engineering into your early planning.

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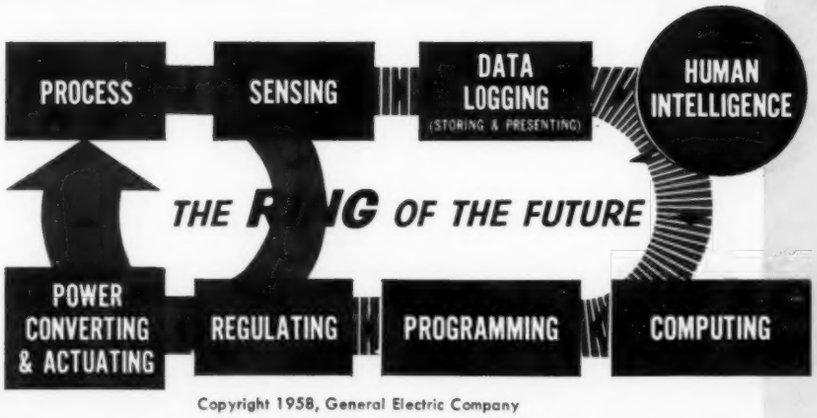

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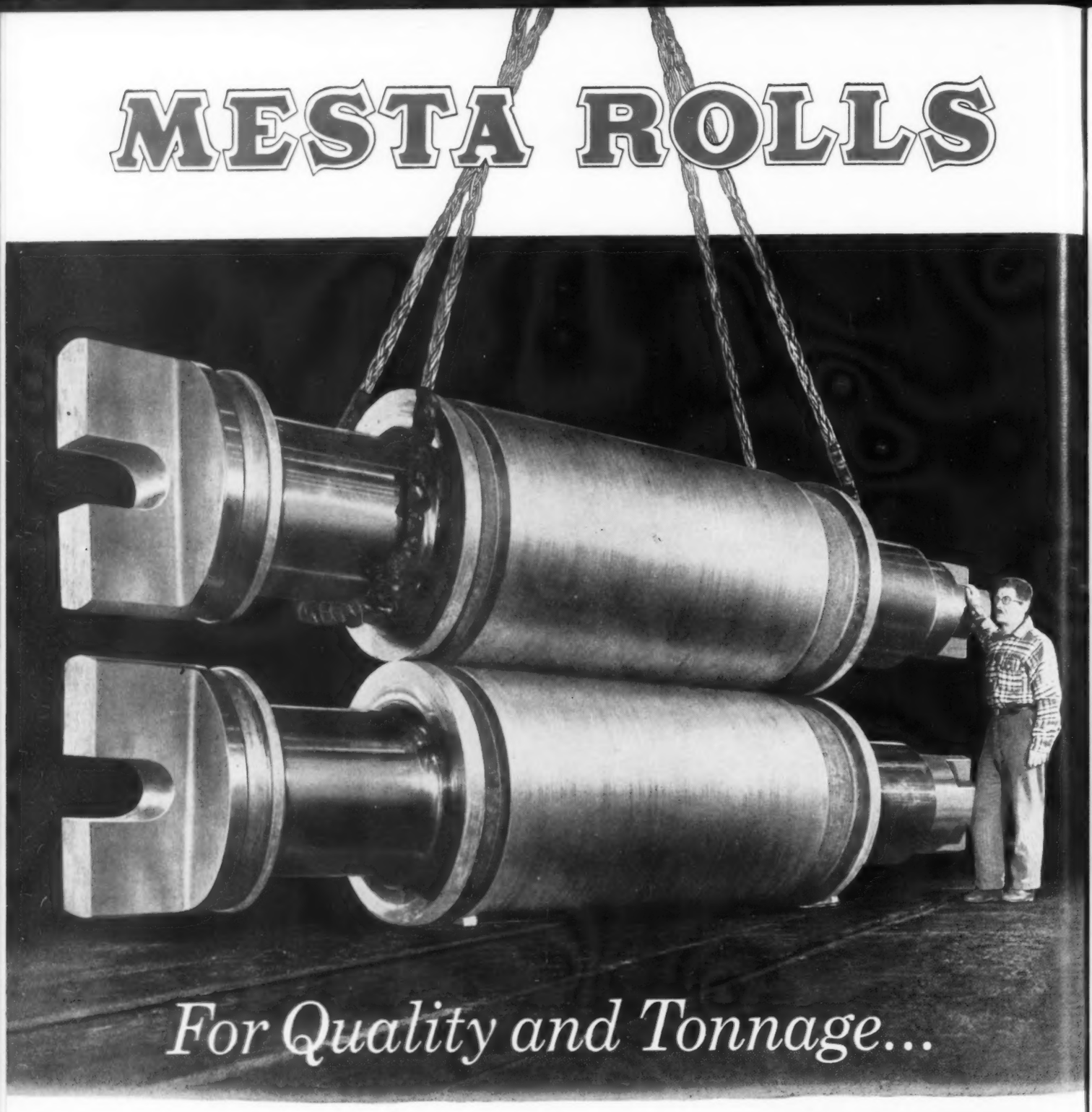

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PITTSBURGH, PENNSYLVANIA

Personnel News...

Richard F. Armitage has been made senior assistant district manager of Republic Steel Corp.'s Warren, Ohio, District. Mr. Armitage, general superintendent of the Warren District since February, 1958, takes over the newly created position immediately. **P. P. Echols,** assistant district manager, continues in that capacity. A veteran of 26 years of service with Republic, Mr. Armitage joined the company as a lubrication engineer in Chicago in 1933. He subsequently served as combustion engineer and general millwright foreman at the Chicago plant and moved to Warren in 1946 as assistant mechanical superintendent. He became mechanical superintendent in 1948 and superintendent of construction in 1956.

Robert A. Kraus has been appointed superintendent of construction at Republic Steel Corp.'s plant in Warren, Ohio. For the past two years, Mr. Kraus has been superintendent of the maintenance department at the company's steel plant in Chicago. He also served there as assistant superintendent of the maintenance department, general mechanical foreman, lubrication engineer, and industrial engineer since joining the company in 1939 as a student engineer.

Terry J. Allen has been appointed assistant superintendent of blast furnaces at the Buffalo, N. Y., plant of Republic Steel Corp. He had been general foreman of Nos. 5 and 6 blast furnaces at the Republic steel plant in Cleveland, Ohio. Mr. Allen has been with Republic since 1937.

Wilson L. Weir and **Andrew E. Engelbert** have been appointed superintendent and assistant superintendent, respectively, of the Cold Finish Department at Jones & Laughlin Steel Corp.'s Stainless and Strip Division plant, Detroit, Mich. Mr. Weir replaces **Otis R. Kendall,** who is retiring after 48 years of service.

Mr. Weir was appointed assistant superintendent of the Cold Finish Department in 1957. He began his steel career at the age of 18 at Crucible Steel Co. of America's Midland, Pa., plant. Between 1934 and 1953 he was field metallurgist and then general stock foreman in the melt shops at Crucible. In 1953 he joined Rotary Electric Steel Co. as general afternoon superintendent and was promoted to assistant superintendent of the Cold Finish Department four years later when Rotary became part of J&L's Stainless and Strip Division.

Mr. Engelbert has been with Rotary Electric and J&L since 1935, with the exception of a two year period. He was promoted to turn leader in 1950 and two years later became foreman in the Cold Finish Department.

Graydon G. Varner has been named chief design engineer, Midwest Steel Corp. At the same time **Robert R. Gobert** was appointed design engineer and **Richard Dick,** project engineer.

Mr. Varner was employed in the Mechanical and Engineering Departments of Weirton Steel Co. from 1935 until 1942. Prior to joining Midwest Steel, he was associated for 10 years with Swindell-Dressler Corp. Mr. Gobert began working at Weirton Steel in 1950. He was employed in the Engineering Department prior to assuming his duties with Midwest Steel. Mr. Dick started in the steel industry with United States Steel Corp. in 1939 in the Inspection Department of the Duquesne Works. Prior to joining Midwest Steel, he was design engineer at the Homestead Works of U. S. Steel.

Jack E. Coddington has been promoted to senior mechanical engineer, the Armco International Corp., and **Albert L. Hacker** has been appointed industrial director of Armco Industrial e Commercial S.A., Armco International's subsidiary in Brazil.

Mr. Coddington began working at Armco as an engineering draftsman in 1951. He was advanced to mechanical engineer in 1953. In 1956, he moved to the technical division of A.I.C. as a civil engineer. Mr. Hacker joined Armco International as a civil engineer in 1957.

C. E. Newcomb has been named manager of research facilities planning by the Crucible Steel Co. of America. Mr. Newcomb, formerly assistant manager of engineering at the company's Midland, Pa., research laboratory, began his employment career in 1937 with Oilwell

R. F. ARMITAGE

R. A. KRAUS

T. J. ALLEN

W. L. WEIR

J. H. THOMPSON

G. W. KROSS, JR.

A. L. HOWARD

E. E. CASPELL

Supply Co. In 1942 he joined Remington Arms Co. where he held several engineering posts. He moved to Midland, Pa., in 1951 to accept a position with Rem-Cru Titanium, Inc. as supervisor of equipment development. In 1953 he was appointed manager of engineering and when Crucible acquired full ownership of Rem-Cru in 1957, Mr. Newcomb was named assistant manager of the Midland research laboratory.

J. Hubert Thompson has been appointed superintendent of the bar mill at the Gadsden Ala., plant of Republic Steel Corp. He succeeds **Paul Moffett,** who recently retired. Mr. Thompson joined Republic in 1926 as clerk to the bar mill superintendent. He became assistant superintendent in 1944, the position held at the time of his recent appointment.

George W. Kross, Jr., was promoted to assistant manager of tubing operations at the Tubular Products Division, Beaver Falls, Pa., plant of The Babcock & Wilcox Co. At the same time, it was announced that **G. E. Pletz** would succeed Mr. Kross as superintendent of the division's Keystone Street plant in Alliance, Ohio. Mr. Kross started with the company at its Beaver Falls plant in 1947 as a student engineer. In 1952 he became assistant to the plant superintendent at the Keystone Street plant and in 1953 he was made assistant superintendent. In 1955 he became plant superintendent.

Mr. Pletz joined the company in 1933. After holding numerous supervisory positions at the Beaver Falls plant, he was named to the works manager's staff in 1953. In 1958, he was made assistant plant superintendent at the division's Keystone Street plant in Alliance.

Arthur L. Howard has been appointed assistant superintendent of open hearth steel production at Kaiser Steel Corp.'s Fontana, Calif., plant. Mr. Howard comes to Kaiser from Granite City Steel Co., where he was superintendent of the Open Hearth Department for the past three years. He started with Granite City in 1934 as a furnace helper in the Open Hearth Department. He progressed to first helper in 1940 and two years later was appointed assistant melter foreman. He became senior melter foreman in 1944, assistant superintendent in 1950 and was appointed superintendent of the department in 1956.

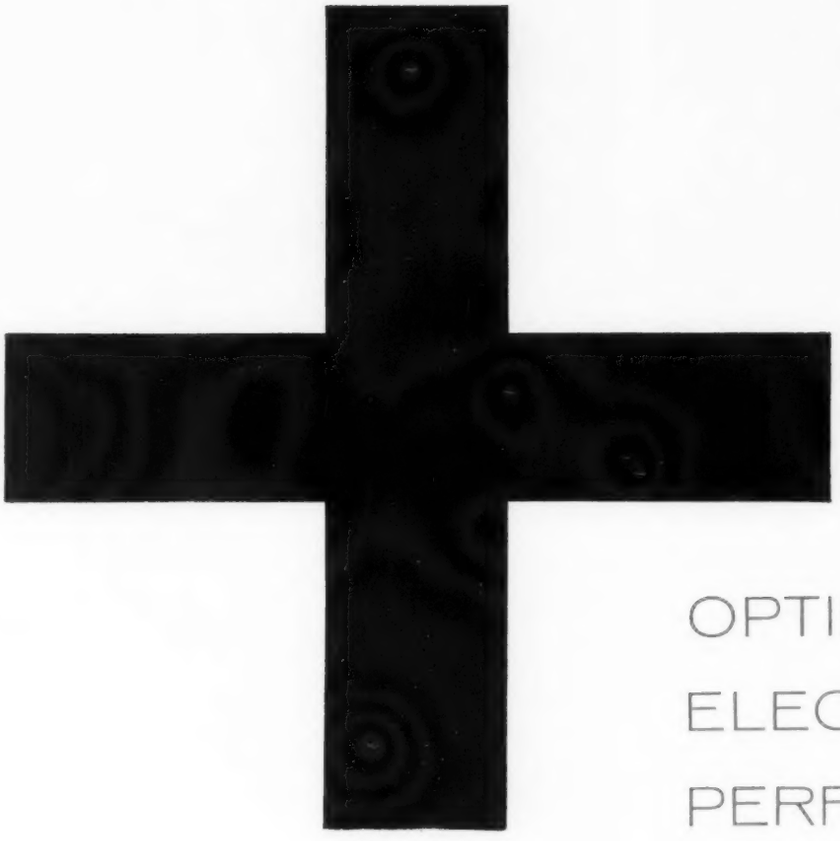
Edwin E. Caspell has been appointed general superintendent of Donora, Pa., Works of U. S. Steel Corp.'s American Steel & Wire Division. Mr. Caspell succeeds **U. F. Corsini,** who died May 10. Mr. Caspell began his career with the Wire Division at Newburgh Works in 1927. He was assigned as a technical apprentice at New Haven, Conn., Works in 1932. He was appointed general foreman there in 1938, and advanced to the position of superintendent of the Wire Rope Department five years later. In 1945, he was appointed works superintendent at New Haven. He became general superintendent for New Haven and Trenton, N. J., Works in 1953, the position he has held until his present appointment.

Louis C. Kemo has been named divisional superintendent—production at Wheeling Steel Corp.'s Benwood Works. Mr. Kemo comes to Wheeling Steel from Jones & Laughlin Steel Corp. Aliquippa, Pa.

Francis J. Herman was named superintendent of open hearths at U. S. Steel Corp.'s Youngstown District Works. He began his career with U. S. Steel in 1933 at the Youngstown District Works as an observer in the Open Hearth Department. In 1936 he was promoted to chief observer and one year later was made observer foreman. In 1938 he was transferred to the corporation's Edgar Thomson Works in Braddock, Pa., as assistant chief metallurgist. He later became general foreman of open hearth and bessemer at that plant. In 1940 he was transferred to the Farrell Works as assistant superintendent of open hearth. In 1954 he returned to Youngstown District Works as general foreman auxiliaries. In 1956 he was made assistant superintendent of the open hearth and in 1958 became superintendent of the bessemer, the position held until the shutdown of this department. Since that time he has worked on special assignments in the steel producing department until his recent appointment.

L. C. KEMO

F. J. HERMAN



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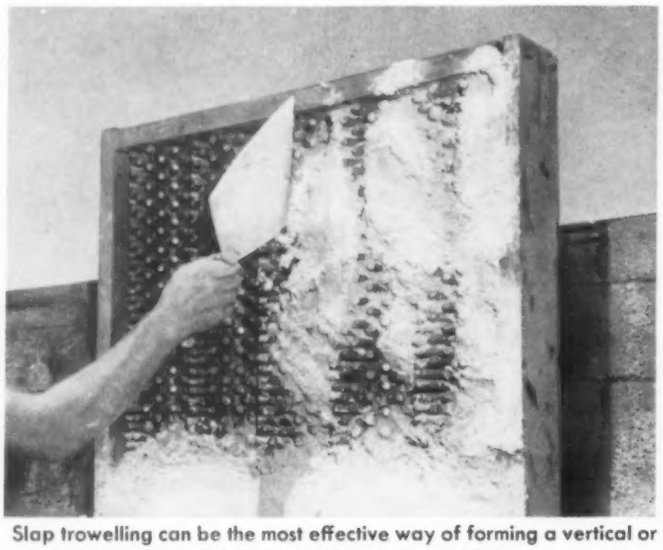
Gunning B&W Kromight-Gun assures complete penetration of irregular areas. This 3200 F refractory material is excellent for studded open hearth doors and similar metalworking installations.



Slap trowelling can be the most effective way of forming a vertical or overhanging section of lining, provided the castable has an exceptionally adhesive, plastic texture. B&W Kaocrete-B, possessing these properties, is widely used in this type of installation.

Vibrating B&W Kaocrete-32 in place to form electrode rings in an electric furnace. This method of installation provides density and strength, and eliminates laminations, air bubbles and pockets, thus permitting economical, long life.

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W. J. WENGER

R. F. RINGHAM

R. K. McCONKEY

W. E. McCOY

W. J. Wenger has been named vice president—roll sales of Blaw-Knox Co., succeeding **A. E. Murton,** who recently was advanced to vice president in charge of the new Foundry & Mill Machinery Group. Named to succeed Mr. Wenger as assistant manager of roll sales is **Richard F. Ringham**, formerly roll sales engineer. Mr. Wenger began his business career with Birdsboro Foundry & Machine Co. in 1935 as assistant metallurgist in charge of the Roll Department. He joined Continental Foundry & Machine Co. in 1942 in a roll sales capacity. After that firm was acquired by Blaw-Knox in 1955 he was named assistant manager of roll sales. Mr. Ringham joined Continental Foundry & Machine in 1941. He joined the roll sales force in 1948 and in recent years has been serving as roll sales engineer.

James M. Richardson has joined the Tool Steel Gear, and Pinion Co.'s Market Research Department. He formerly served with the Colorado Fuel and Iron Corp., and Great Lake Steel Corp.

John A. Jones has been appointed director of public relations for Weirton Steel Co., division of National Steel Corp. He joined Weirton in 1943 and served in various public relations capacities, including the editorship of the "Employees Bulletin". In 1958, Mr. Jones was named assistant to the manager of industrial relations, and served in that capacity until his present appointment. **Paul F. Harris,** director of publications and publicity, will assume the duties peviously performed by Mr. Jones, and **Robert M. Rine** has been named assistant director of the Publications and Publicity Department.

R. K. McConkey has been promoted to the position of general manager of the Industrial Division of The Timken Roller Bearing Co. Mr. McConkey started with Timken in 1935. He was assigned to the company's Milwaukee, Wis., office in 1937 as a sales engineer. He was then successively Los Angeles, Calif., district manager of the Industrial Division; district manager of Industrial Division, Milwaukee; and Moline, Ill., before he was named assistant general manager of the Industrial Division in 1953, the post he held before his recent promotion. Succeeding to the position of assistant general manager of the Industrial Division is **Wyn E. McCoy.** Starting with the company in 1940 as a sales trainee, he was successively a sales engineer, Chicago district manager of the Industrial Division and sales promotion manager before his promotion to assistant general manager, Industrial Division.

A. E. Matejka has been named to the post of chief product engineer. Starting with Timken in 1937 he worked on special assignments in the Engineering, Metallurgical and Production Divisions of the company. In 1941 he became a tool designer and in 1948 was named assistant to the chief tool engineer. In 1952, he was named assistant chief product engineer, the post he held until his new appointment.

C. L. George has been named to the post of assistant chief product engineer. Starting in 1946 as a draftsman he was promoted to design engineer in 1951, the post he held until his present promotion.

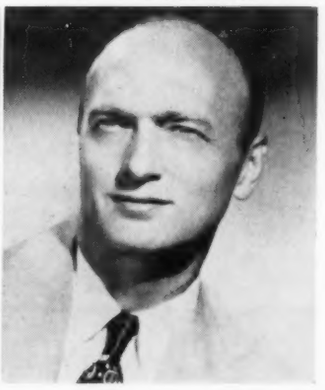
James P. Haas has been appointed manager of research and development for the Metal Products Division of Koppers Co., Inc. Mr. Haas joined Koppers at Baltimore in 1954 as chief project engineer. In 1957, he was named manager of the technical department of the division, the position he held prior to his latest promotion.

Jacob J. Jaeger, formerly executive vice president, has been elected president of Pratt & Whitney Co. He succeeds **Edward P. Gillane,** who has been elevated to the position of assistant to the chairman of the board. Election of **Edward J. Shages** to the board of directors was also announced. He is vice president in charge of manufacturing.

R. A. Haworth has been named apparatus sales manager at Cutler-Hammer Inc. Formerly manager of the company's midwest sales region, Mr. Haworth fills a position vacated recently when **E. B. Fitzgerald** was

J. J. JAEGER

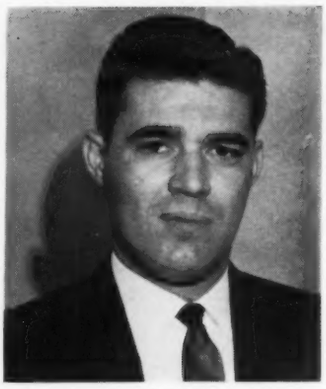
R. A. HAWORTH



J. S. KLINE

N. C. HUNT

L. A. BATEMAN



A. V. NEY

named vice president in charge of engineering. Mr. Haworth started with Cutler-Hammer in 1934. Prior to being named a regional manager earlier this year, he had been in charge of the Chicago, Ill., office. Before that he had managed sales in Baltimore, Md., and Dallas, Texas.

John S. Kline has been appointed general manager and chief executive of the Carpenter Steel Co.'s Alloy Tube Division, Union, N. J., succeeding **P. L. Coddington.** Mr. Kline has been assistant general manager of the Alloy Tube Division since October, 1958. Mr. Coddington retired July 1 after 17 years of service with the company. He has been retained as a part time consultant.

N. C. Hunt, founder of Hunt Valve Co., has come out of retirement to take over as president and chairman of the board. **Lester A. Bateman** has been named executive vice president. He was formerly assistant to the president. He joined Hunt early this year, coming from the Eljer Co., where he was manager of that firm's enamelware division. **Andrew V. Ney** has been promoted to sales manager. Formerly assistant sales manager, Mr. Ney joined Hunt as a sales engineer in 1957.

Charles W. Glunk has been named manager of basic sales and service of A. P. Green Fire Brick Co.'s new basic refractories plant at Tarentum, Pa. Mr. Glunk was manager of sales engineering of the Company's affiliate, A. P. Green Fire Brick Co., Ltd., in Toronto, Canada, prior to his current appointment. He will be assisted by sales engineers **R. A. Witschey** and **John Sack. William G. Maloney** is in charge of production of the Tarentum operation. He has worked in various capacities in the organization for 22 years.

Granville M. Read, retired chief engineer of the Du Pont Co., has joined Blaw-Knox Co., as consultant to the president in research, engineering and development.

Robert A. Barr has been appointed general manager of The Babcock & Wilcox Co.'s Refractories Division. Mr. Barr formerly was assistant general manager of the Refractories Division of The Carborundum Co.

Irving B. Gruber, vice president of American Forge and Manufacturing Co., for the past 13 years, has been named president of the company. Mr. Gruber served as general manager of the Sawhill Manufacturing Co.,

R. A. BARR

I. B. GRUBER

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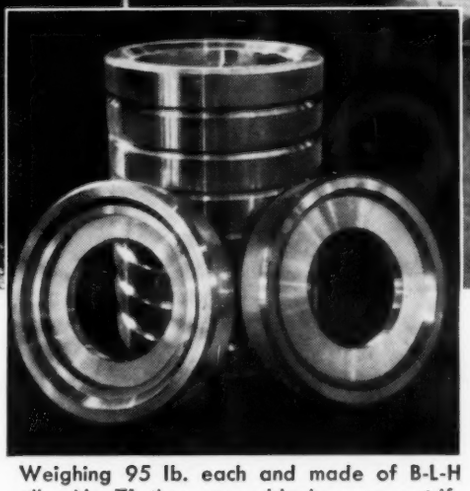
At Eddystone two hot strip mill slippers cast of B-L-H alloy No. 83 are machined on a vertical boring mill.



Weighing 95 lb. each and made of B-L-H alloy No. 71, these gear blanks were centrifugally cast and machined at Eddystone.

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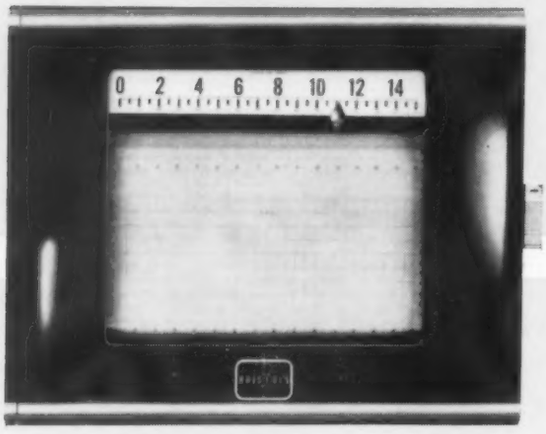
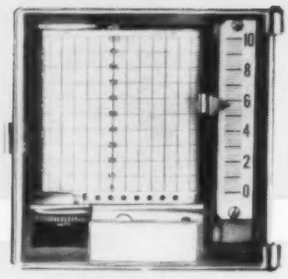
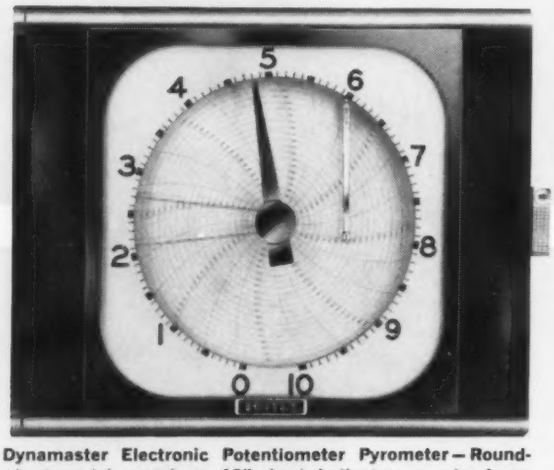


Dynamaster Electronic Potentiometer Pyrometer—Strip-chart model records on chart 11" wide, 120' long.



Miniature Electronic Dynamaster Pyrometer—Records on 3" strip-chart. Indicator model features easy-to-read 9" scale length.

Bristol Millivoltmeter Pyrometers—Free Vane* pyrometer controllers (shown) or indicating types. Many control modes available.



Dynamaster Electronic Potentiometer Pyrometer—Round-chart model records on 12" chart, indicates on extra large scale.

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Bristol recording and automatic controlling pyrometers for temperatures up to 5000°F can help you increase product uniformity, cut fuel and maintenance costs

Bristol makes a wide range of pyrometers for every requirement: Electronic potentiometers, millivoltmeter and radiation types . . . for furnaces, ovens . . . every type of heating equipment, every kind of fuel. The reliability and accuracy of these precision instruments have been proved in thousands of installations.

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Continuous standardization in Dynamaster Electronic Pyrometers requires no dry-cells, **but still retains the precision standard cell for highest stability and accuracy of voltage reference.** Results: No interruption to operation, no batteries to change. And here are just a few of the Dynamaster types available:

A model for every requirement: Dynamaster Pyrometers are available as single-pen, two-pen, and multiple-record (up to 24 points) *strip-chart* instruments and as *round-chart* instruments.

Electric and pneumatic controllers: Both strip- and round-chart instruments are made in a very wide variety of controllers that meet every furnace and oven control requirement, including the following in a great many forms:

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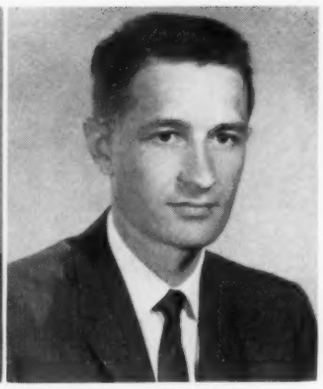
J. D. MORROW



H. B. CARR

prior to his affiliation with American Forge in 1946. Previously, Mr. Gruber was with National Tube as assistant chief industrial engineer.

J. D. Morrow was appointed vice president and treasurer, and **H. B. Carr,** vice president—engineering, S. P. Kinney Engineers, Inc.

Louis V. Abrams has joined Pangborn Corp. in the newly created post of administrative assistant to the president.

Obituaries

L. V. (Roy) Black died on June 28, 1959, in the White Canyon Area of Natural Bridge National Monument in Utah while on vacation. Death was accidental with immediate cause being extreme exposure and dehydration which occurred after apparently being lost in the park. Mr. Black retired about a year ago as superintendent, electrical department, Bethlehem plant, Bethlehem Steel Co., which position he had held for many years. Mr. Black had been very active in AISE affairs and was a life member of the AISE. He would have been 67 years old in August.

Lanier Greer, chief engineer of d-c machine design and electrical insulation at Reliance Electric and Engineering Co., died July 1. Mr. Greer joined Reliance Electric and Engineering in 1947 as consulting engineer, d-c design, and until his death directed the design and development of the Company's industrial direct-current machines and motors for underground mining applications. He also headed the company's program of research and development on electrical insulation.

Carlton B. Smith, director of service for Allis-Chalmers Manufacturing Co.'s Industries Group, died July 6. He was 63. Mr. Smith joined Allis-Chalmers in 1914 as a machinist apprentice. Three years later he became a field service and erection supervisor. In 1941 he was named superintendent of the service and erection department's Atlanta district. He became manager of the service and erection department in 1951 and director of service in 1957.

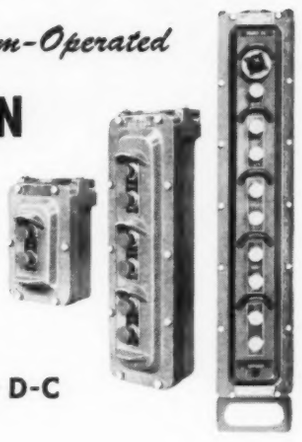
Albert I. Davey, retired vice president of Empire Steel Corp., died July 5.

Sir Frederick Pickworth, chairman of English Steel Corp., Ltd., died July 14.

For Hazardous Locations

Heavy-Duty, Cam-Operated

PUSH-BUTTON STATIONS



600 Volts
A-C or D-C

● The Euclid Electric & Mfg. Co. (Madison, Ohio) has added a complete new line of Pendant Push-Button Stations for all applications that necessitate NEMA Types 7 and 9 enclosures to meet hazardous-location requirements. Designed for heavy-duty applications, these cam-operated Stations are rated 600 volts, a-c or d-c. They are available from one to five speed-points in each direction for a total of eight circuits to provide for practically an unlimited number of different sequences of operation.

Sturdily constructed to withstand hard usage and abuse, their small cross-section permits comfortable, non-fatiguing, one-hand operation. Where required, a bottom holding handle can be supplied. The dense cast-aluminum enclosure can be readily opened for inspection of the silver-to silver contacts without disturbing any wiring. The conduit hole is threaded and a double-suspension cable hanger is provided.

Extra features include heavy-duty, control-circuit toggle disconnects, pilot lights, selector switches, and maintained-type contacts.

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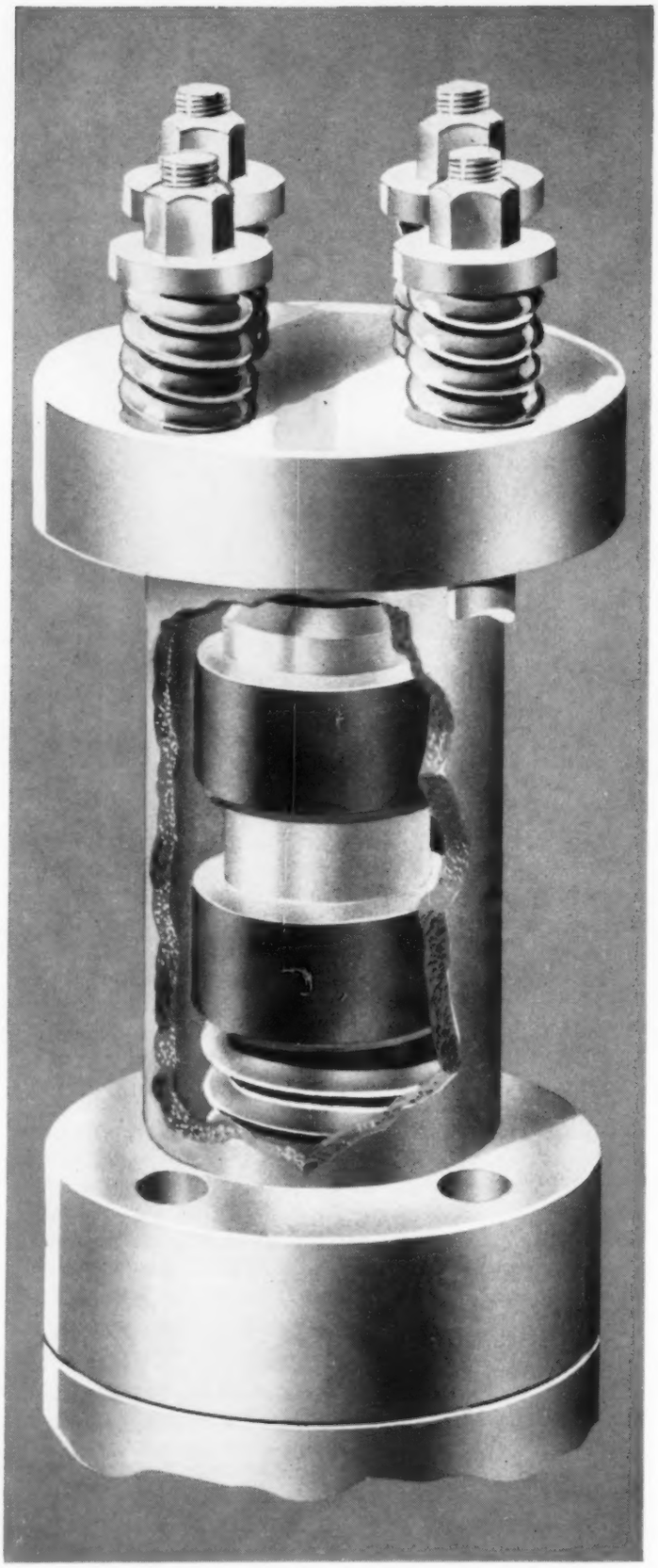
by bringing you lower precipitator maintenance and operating costs with

K-30*

bonded pistons on pneumatic vibrators



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*Koppers Trademark

†E. I. duPont de Nemours & Company, Inc. trademark for tetrafluoroethylene resin

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The finish must be perfect on this hardened steel roll

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When next in the market for forged rolls, why not check with us first? We make them in all sizes, and for every application: cold-rolling ferrous sheets and strip; running-down and finishing operations on copper and brass sheets; hot- and cold-rolling aluminum sheets; cold-rolling aluminum foil. Our prices and deliveries are fully competitive. Our nearest sales office can give you full details.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export distributor: Bethlehem Steel Export Corporation.

BETHLEHEM STEEL

BETHLEHEM STEEL

Superex is easily combined with other insulations such as Johns-Manville Thermobestos®, J-M 85% Magnesia or J-M Insulating Fire Brick.

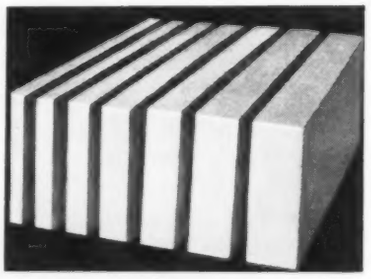
Only Johns-Manville Superex insulation performs 3 ways better at high temperature!

Few industrial products are so outstandingly superior, or so widely used in their area of application, as Johns-Manville Superex® Insulation.

A block insulation formulated of diatomaceous silica and asbestos for furnace and other applications, Johns-Manville Superex brings many advantages to high-temperature service—each contributing to reduced construction, maintenance and operating costs.

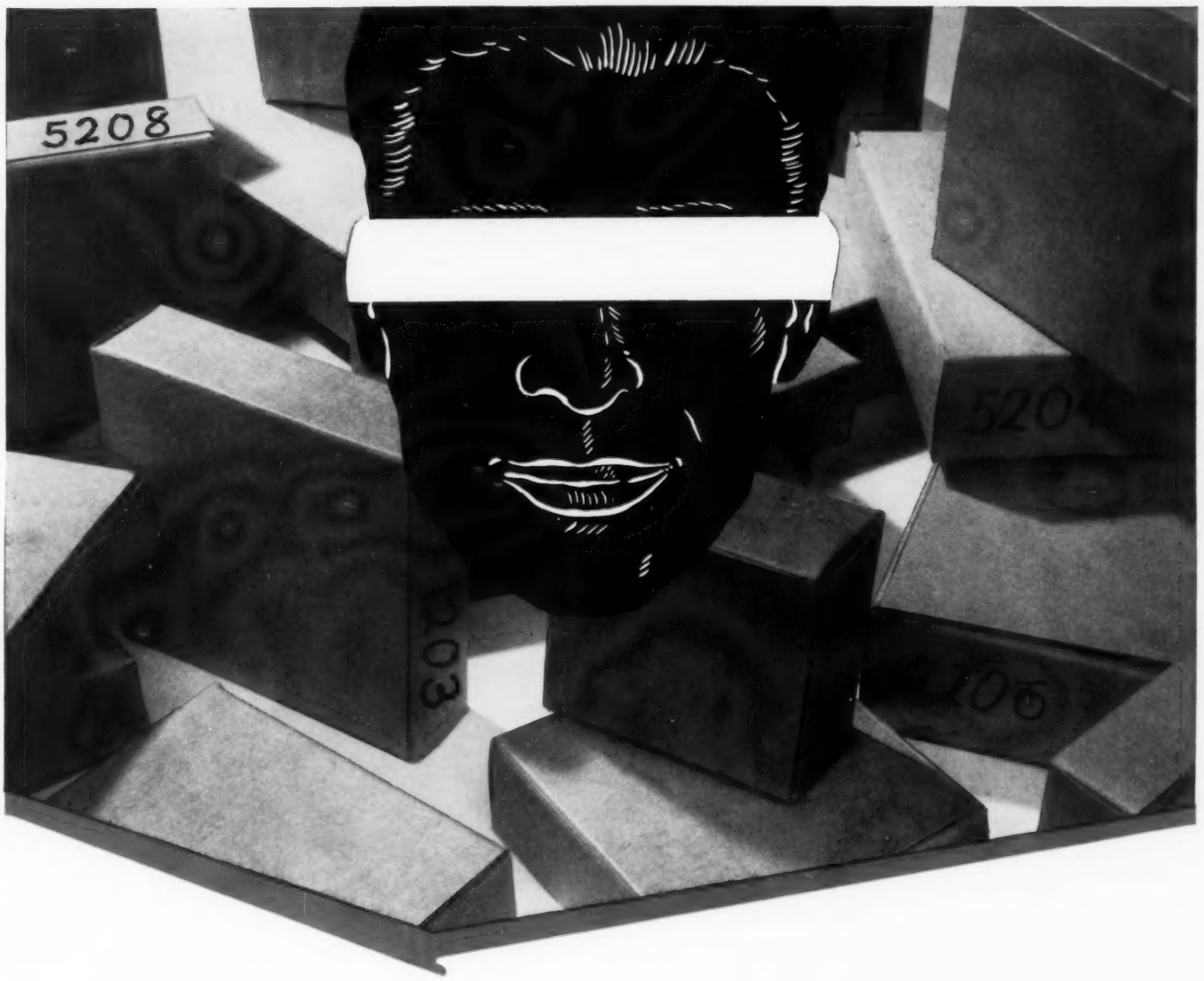
Superex is installed with measurable savings in time and labor! It is easy to cut and handle . . . weighs only 2 lbs. per sq. ft. per inch thickness . . . available in a wide variety of large block shapes and sizes. At high temperature—the material's excellent insulating value, thermal stability and resistance to shrinkage keep fuel costs low. Equally important—Superex saves on maintenance, too . . . easily withstands the daily abuse of normal service.

Send for your copy of IN-190A, the 12-page design and technical data brochure. It lists suggested applications—gives complete heat transmission tables and performance data. *Write for it today.* Address Johns-Manville, Box 14, N.Y. 16, N.Y. In Canada, Port Credit, Ont.



Saves waste. Superex comes in 7 standard thicknesses from 1″ to 4″. Other sizes available on order.

JOHNS-MANVILLE JOHNS-MANVILLE JM PRODUCTS



Don't buy bearings blindfolded . . .

Make certain the bearings you buy are in the manufacturers' original, sealed boxes . . . and avoid surplus or shelf worn bearings. These bearings are usually in plain boxes or individually wrapped and often are without any identification except for the bearing number.

If you are not getting "Factory Fresh" bearings you are not buying bearings incorporating the latest design and those which will give the longest life in your equipment. The one easy, certain way to get the bearings you want is to buy from Bearings, Inc.! We're *authorized* distributors for the many lines of bearings and accessories we sell—guaranteed by the manufacturers and Bearings, Inc. Our bearing engineers can recommend the best bearings for all applications and you will save time, trouble and money. Call the branch nearest you!

Providing bearing service in the North »

BEARINGS, INC.

OHIO: Akron • Canton • Cincinnati • Cleveland • Columbus • Dayton • Elyria • Hamilton • Lima • Lockland • Mansfield • Toledo • Youngstown • Zanesville
INDIANA: Ft. Wayne • Indianapolis • Muncie • Terre Haute • **PENNSYLVANIA:** Erie • Johnstown • Philadelphia • Pittsburgh • York
WEST VIRGINIA: Charleston • Huntington • Parkersburg • Wheeling • **NEW JERSEY:** Camden
NEW YORK: Balanrol Corp.. Buffalo • Niagara Falls • **MARYLAND:** Baltimore • **DELAWARE:** Wilmington

and

in the South »

DIXIE BEARINGS, INC.

FLORIDA: Jacksonville • **GEORGIA:** Atlanta • **KENTUCKY:** Louisville • **LOUISIANA:** Baton Rouge • New Orleans
N. CAROLINA: Charlotte • Greensboro • **S. CAROLINA:** Greenville • **TENNESSEE:** Chattanooga • Kingsport • Knoxville • Nashville
VIRGINIA: Richmond

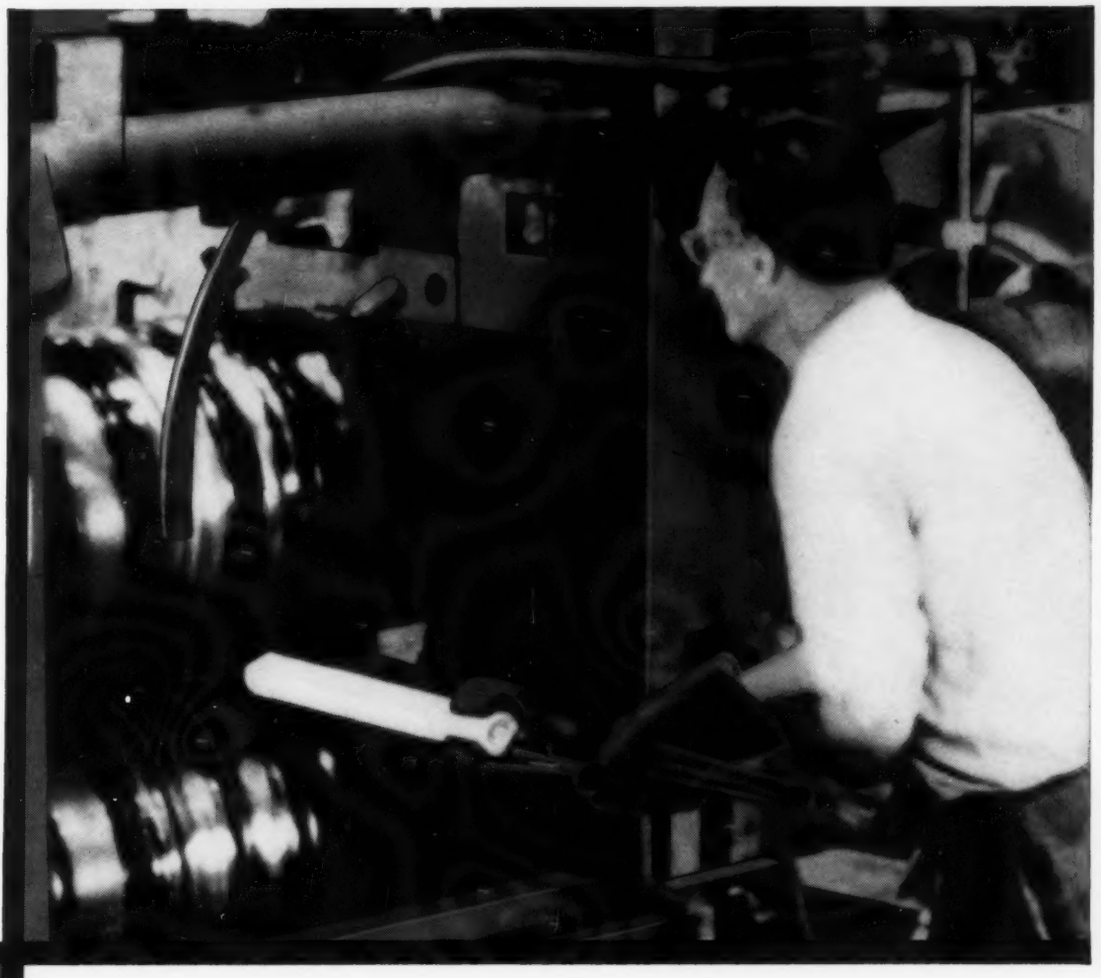
ENGINEERED AIR (by AAF) keeps it clean!

● This intricate control panel at Jones & Laughlin Steel Corporation's Cleveland Works typifies the importance J&L places on the operation of its electrical equipment. Typical, too, was their insistence on the *right* kind of protection against dust damage.

J&L installed *five different types* of AAF filters to meet the differing clean-air needs of equipment serving its open hearth shop, blooming mill, finishing division and sintering plant. Result: at each filter installation, J&L has the *air cleaning efficiency it needs* plus *the maintenance characteristics it wants.*

To make sure you get clean air that's engineered for *your* specific needs, talk with the *one* company that makes *all kinds* of air filters—AAF. For more information, call your local AAF representative or write us direct. Address: Mr. Robert Moore, American Air Filter Company, Inc., 302 Central Avenue, Louisville, Ky.

AAF American Air Filter
BETTER AIR IS OUR BUSINESS



B

where something ***special*** *is required...*

BIRDSBORO *rolls and rolling mill machinery*

• Whether it's intricate experimental rolling, the taming of hard-to-work steels, or rough, tough, high production duty . . . Birdsboro's specialized mill machinery, or the complete family of rolls, has something specific to offer. You can measure the difference in your own plant: Increased mill production, less metal removal per roll dressing. A talk with your Birdsboro man can fill in other important details. *Sales Department, Engineering Department and Plant:* Birdsboro, Pa., *District Office:* Pittsburgh, Pa.

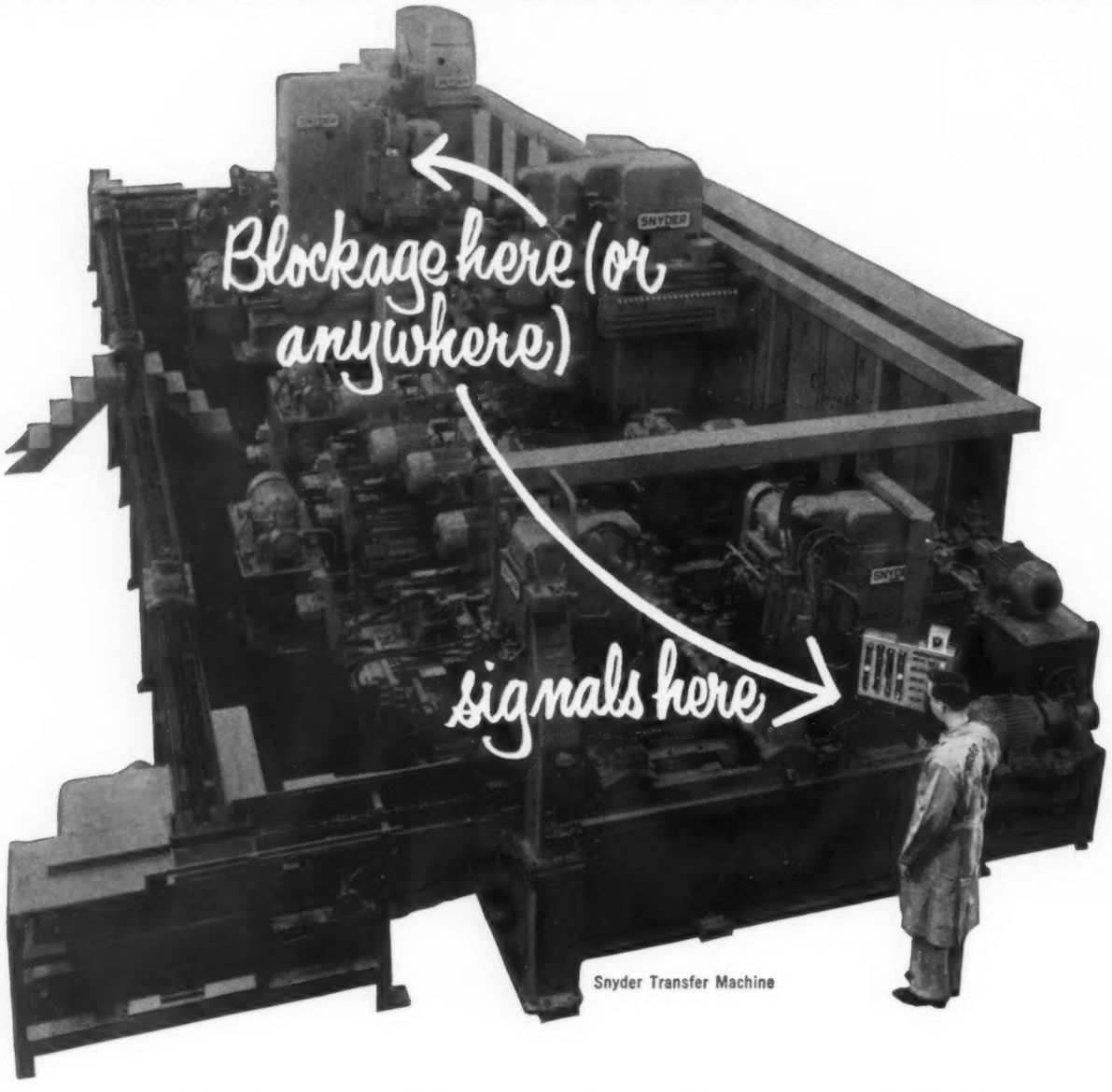
MM 25-58

BIRDSBORO
STEEL FOUNDRY AND MACHINE CO.

STEEL MILL MACHINERY • HYDRAULIC PRESSES • CRUSHING MACHINERY • SPECIAL MACHINERY • STEEL CASTINGS • Weldments "CAST-WELD" Design • ROLLS: Steel, Alloy Iron, Alloy Steel

TRABON®

CENTRALIZED LUBRICATING SYSTEMS



Snyder Transfer Machine

First with Central Warning in a Centralized System!

Yes, Trabon's positive piston operation gives you a truly centralized oil or grease system — making sure that every bearing gets its accurate measured amount — **and giving you central warning** at the pump or control panel when a bearing is blocked **anywhere** in the system.

For example, on this 60 foot transfer machine a red fault light located at the operator's station gives immediate warning in case of blockage 10 feet or 60 feet away. There is no need to make tedious, time-wasting inspection trips at frequent intervals to make sure all bearings are getting a positive shot of lubricant. Trabon does the job for you! And—should blockage occur—finding the trouble spot is easy! For Trabon's inexpensive Reset Indicators enable you to pinpoint the blocked condition in a matter of seconds.

Why not specify Trabon for your machinery investment. It's the modern, better way to lubricate positively and safely! (And versatile Trabon systems can be operated automatically by air, hydraulic, electric or mechanical actuation.)

"Centralized" OIL AND GREASE SYSTEMS "Meterflo" CIRCULATING OIL SYSTEMS

Trabon® **Trabon Engineering Corporation** 28785 Aurora Road • Solon, Ohio

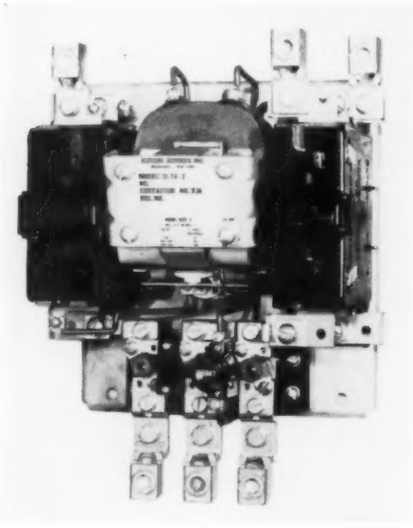
Equipment News...

STARTER

△ Cutler-Hammer Inc., has added the Size 4 starter to its 3-star line of magnetic starters.

Chief feature of the Size 4 is a new contact structure which minimizes contact bounce and provides longer operational life under the severe current demands associated with Size 4 applications. The starter is equipped with parallel-double break contacts. Each set of contacts is vertical, dust-safe, nonwelding and sintered; and each utilizes a flexible jumper, thus providing more points of contact and more available current paths.

Other standard features on the new starter are molded magnet coils,



precision-cast heater coils, contact block provisions for externally mounting four additional interlock units and removable lugs for easy installation.

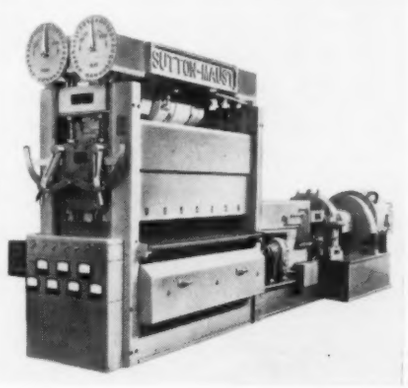
Small and compact, the Size 4 is available in a wide range of NEMA enclosures.

LEVELERS

△ Sutton Engineering Company has announced a complete line of Sutton-Maust roller levelers for precision flattening and correcting ferrous and nonferrous sheets and strip, including tension leveling of coil stock. All sizes are available for all modern metals of any required width and in gages from 0.001 in. to 0.750 in.

Featured is the Maust patented, double-tilt, backed-up roll arrangement which provides better flatness and correction of mill shapes. The work rolls are cradled by multiple banks of adjustable backup rolls. The top work rolls are arranged in a symmetrical pattern with the entry and exit rolls adjustable for upward tilt. The entry rolls subject material to gradually increasing waves, the centrally located roll group produces a series of uniformly deep waves for maximum correcting work and the exit group completes the flattening process.

Because of the symmetrical arrangement of the double-tilt design, the flow of material may be reversed backward or forward at any time, without adjustment. And, because work is funneled into the machine at the tilted ends, burnish marks, caused by more severe entry conditions of other designs, are eliminated. No pinch rolls are required.



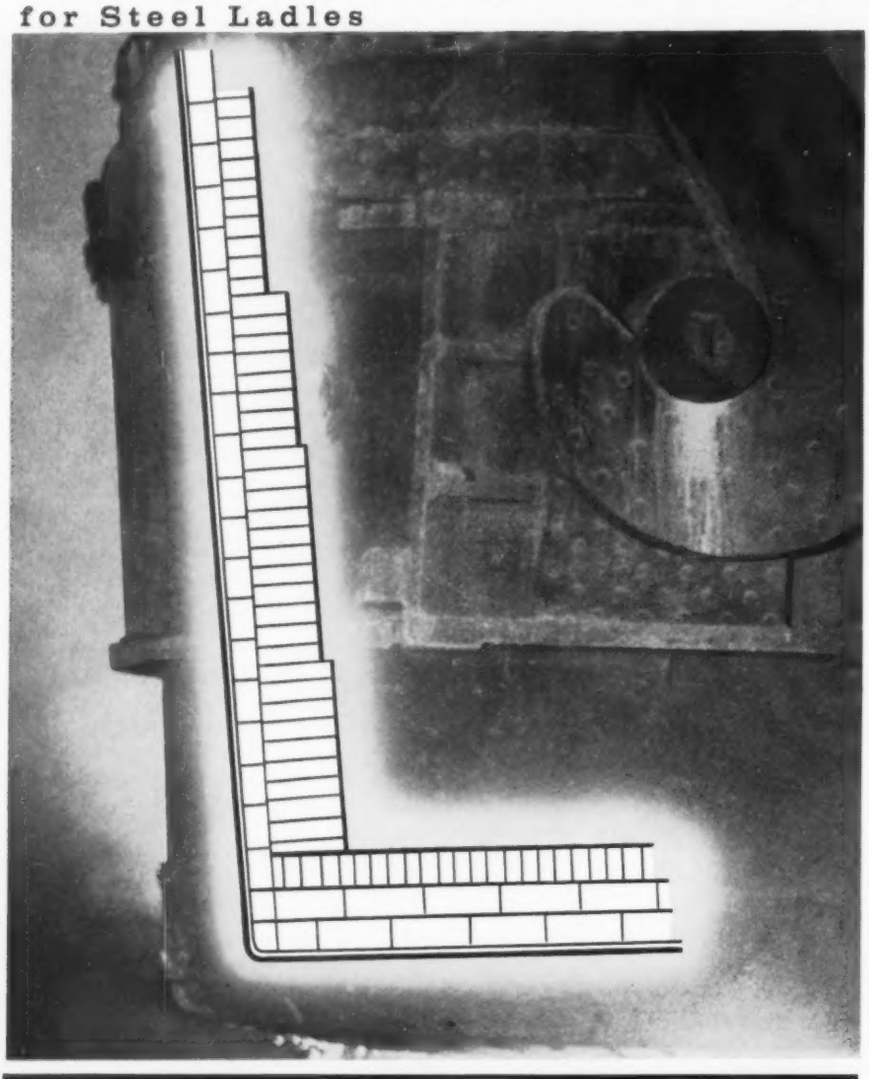
REMINGTON ANNOUNCES "SOLID STATE" COMPUTER

The first "solid-state" electronic computer to be made commercially available in the United States was unveiled recently by Remington Rand. Known as the Univac Solid State, the new computer system performs the functions of its large-scale predecessors, but with the advantages of lower cost, reduced maintenance and lower power requirements. It takes up far less floor space and functions in microseconds—millionths of a second. The computer will rent for $6950 a month, or it may be purchased at $347,500. Deliveries in the United States started in July and several were delivered late last year in Europe. The computer is comprised of a central processor, a card reader, a read-punch unit and a high-speed printer that pours out printed results at the rate of 600 lines a minute. The new computer's "memory" storage capacity of 50,000 characters of information allows the user to perform complete problems in one run, again minimizing actual operating time. The Solid State is expected to be especially useful at installations where several punched-card applications now exist, or where a single large-scale application is in use. Besides payroll and accounting functions, units offer good possibilities for actual production and process control.

DANDO

CHORD BRICK LININGS

for Steel Ladles



over 8,000 tons of steel before relining

That's the kind of record DANDO Chord Brick are making. And this tonnage is matched by an economical first cost. These same price and performance factors will give *you* a lower ladle cost per ton of steel.

Why not investigate DANDO Chord Brick Linings for your ladles? Write *McLain Works, Refractories Division, H. K. Porter Company, Inc., Porter Building, Pittsburgh 19, Pa.*

REFRACTORIES PORTER DIVISION

H.K. PORTER COMPANY, INC.

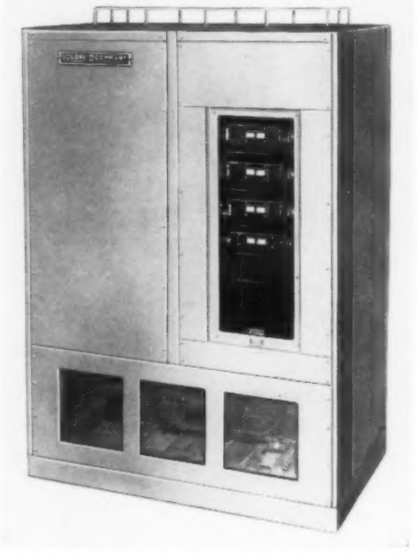
PORTER SERVES INDUSTRY: with Rubber and Friction Products—THERMOID DIVISION; Electrical Equipment—DELTA-STAR ELECTRIC DIVISION, NATIONAL ELECTRIC DIVISION; Copper and Alloys—RIVERSIDE-ALLOY METAL DIVISION; Refractories—REFRACTORIES DIVISION; Electric Furnace Steel—CONNORS STEEL DIVISION, VULCAN-KIDD STEEL DIVISION; Fabricated Products—DISSTON DIVISION, FORGE AND FITTINGS DIVISION, LESCHEN WIRE ROPE DIVISION, MOULDINGS DIVISION, H. K. PORTER COMPANY de MEXICO, S. A.; and in Canada. Refractories, "Disston" Tools, "Federal" Wires and Cables, "Nepcoduct" Systems—H. K. PORTER COMPANY (CANADA) LTD.

The multiple banks of backup rolls are individually adjustable so that localized pressure can be exerted to any portion of the sheet to remove mill shape from the material. They are pivotally mounted to conform with work roll deflection patterns. Design of the backup roll arrangement prevents work roll markings.

The double-tilt levelers may be used in process lines, cut-to-length lines or tension leveling lines. Motorized adjustments permit remote control in processing lines. Tension leveling makes possible precision flattening of thinner stock and a wider range of gages and materials. With tension leveling, time can be saved by processing material in coil form rather than in sheets, with no sheering waste.

UNIT SUBSTATION

△ Available from Square D Co. is a new low-voltage "Power-Zone" package unit substation for use on 480-volt systems to supply 120/208Y circuits. Designed for lighting, office equipment and similar loads, the substations contain three-phase transformers from 75 kva to 300



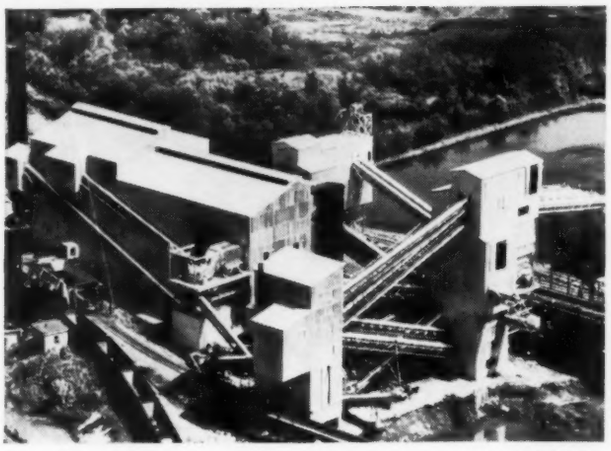
kva. Up to 72 in. of panel space is available for molded case circuit breakers.

Compactly built, the substation is only 60 in. long, 36 in. deep and 79½ in. high. These dimensions provide easy movement through commercial doorways, minimize installation space. Where space is critical, substations may be installed against the wall.

The open-ventilated dry-type

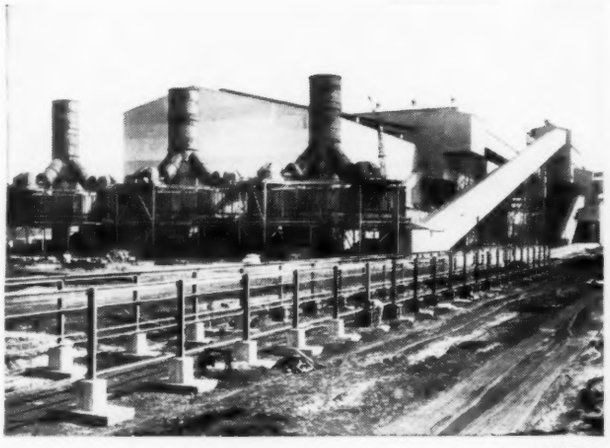
(*Please turn to page 193*)

First these:



ARMCO

McLOUTH



GARY

SAXONBURG

and now:

THE WORLD'S LARGEST SINTER MACHINE

Sinter machine width: 13′ 2″

Sinter machine length: 184′

Sinter machine area: 2419 sq. ft.

Engineering constructor—Dravo Corporation

For: Jones & Laughlin Steel Corporation, at Aliquippa, Pennsylvania

DRAVO
CORPORATION
PITTSBURGH 22, PA.

Service and

YEAR AFTER

Time Proven YEAR...

MEX-R-CO Graphite-base Products are recognized for their consistent and outstanding quality of DEPENDABILITY wherever molten metal or slag is being conveyed or contained.

In Service HELSPOT Will . . .

. . . ***Minimize Metal Contamination***

Inclusions are practically eliminated, resulting in cleaner metal, fewer rejections

. . . ***Facilitate Slag Removal***

With less skull formation and adhesion longer ladle-life naturally results

. . . ***Resist Thermal Shock***

Super-Duty clay and graphite blend produces unusually high spalling resistance

. . . ***Provide Free-flow Surface***

HELSPOT is non-wetting; molten metal flows without penetrating or sticking

In Service HELSKOTE Will . . .

. . . ***Reduce Stickers by 90%***

Save on stripping time; Put molds in use quicker; More ingots poured

. . . ***Increase Stool Life***

Result will be greatly reduced stool cost per ton of ingots poured

. . . ***Cut Buggy Maintenance***

Broken wheels, axles and springs, and track repair costs will be reduced

. . . ***Reduce Busy-Crane Time***

Faster ingot delivery to soaking pit; Quicker release of molds for re-use

NOW LET'S HAVE A LOOK AT COSTS

The "price per ton" of a graphite-base product should not be the sole criterion for determining its value. Rather, the value of the product should be gauged by its effect upon the over-all costs of production per unit of output.

Basic costs—transportation, handling, brick layer's time, etc.—are the same for an untried, unproven or inferior product as for one of proven and dependable year-in, year-out performance.

Weighing these factors (plus output loss due to more frequent shutdowns for untimely repair or rebuilding), it becomes evident that graphite products of lowest cost DO prove to be the most expensive in the over-all cost analysis.

That is why industry has developed a healthy appetite for graphite-base products with proven service performance, that do cut costs of production, that do hold down inventory costs.

The evidence is conclusive that the over-all costs of containing and/or conveying molten metal CAN be controlled by the utilization of MEX-R-CO Graphite-base Products.

MEXICO REFRACTORIES COMPANY

Division of KAISER ALUMINUM & CHEMICAL SALES, INC.

MEXICO, MISSOURI

AROUND THE CLOCK SERVICE FROM WAREHOUSES, ENGINEERING AND SALES OFFICES

BALTIMORE • BATON ROUGE • BIRMINGHAM • BOSTON • BUFFALO • CANTON • CHATTANOOGA • CHICAGO
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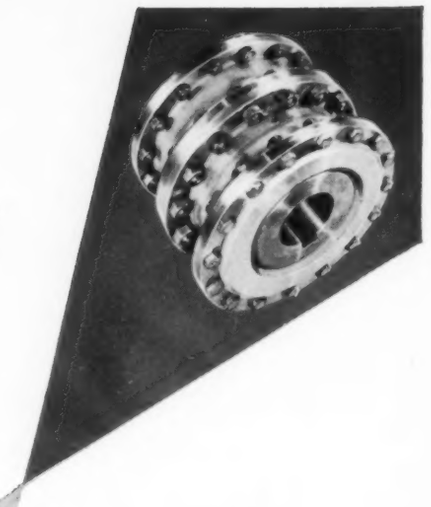
MINNEAPOLIS • NEW ORLEANS • NEW YORK • PHILADELPHIA • PITTSBURGH • PORTLAND • ROCK ISLAND
SAN FRANCISCO • SEATTLE • ST. LOUIS • TOLEDO • TULSA

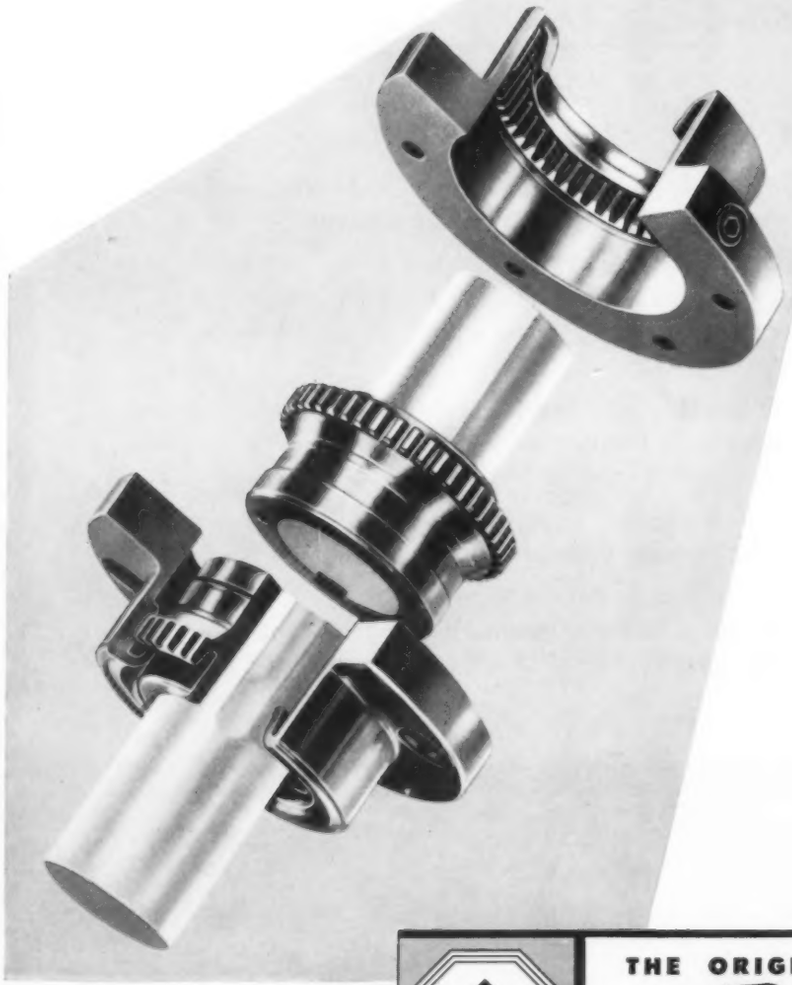
In Canada: EDMONTON (ALTA.) • HAMILTON (ONT.) • MONTREAL (QUE.) • VANCOUVER (B. C.) • WINNIPEG (MAN.)

LOOK under "Brick-Fire" in the classified section of your telephone directory for name of your local Mex-R-Co Distributor.

the basic coupling principle that couldn't be improved . . .



This principle makes every Fast's coupling . . . large or small . . . out-perform all others



The principle embodied in Koppers gear-type, self-aligning Fast's couplings couldn't be improved by anyone. Throughout industry, Fast's couplings are accepted as the most dependable couplings on the market. Experience has proved that they frequently *outlast the equipment* they connect.

Fast's couplings are sufficiently comprehensive in types, sizes and versatility to meet almost every known need for couplings. Available in forged steel for shaft sizes from ¾" to 6⅝" and in cast steel for shaft sizes from 5½" to 32".

Nearly 40 years of coupling experience guarantees that Koppers can supply the right coupling engineered for a given application. For the booklet describing Fast's couplings applicable to your equipment, write today to: KOPPERS COMPANY, INC., Fast's Coupling Department, 5008 Scott Street, Baltimore 3, Maryland.

KOPPERS

THE ORIGINAL

FAST'S Couplings

Engineered Products Sold with ***Service***

(*Continued from page 188*)

transformers are designed for quiet operation. Sound levels have been reduced to 45 db for sizes up to 150 kva, 52 db for 225 kva and 56 db for 300 kva.

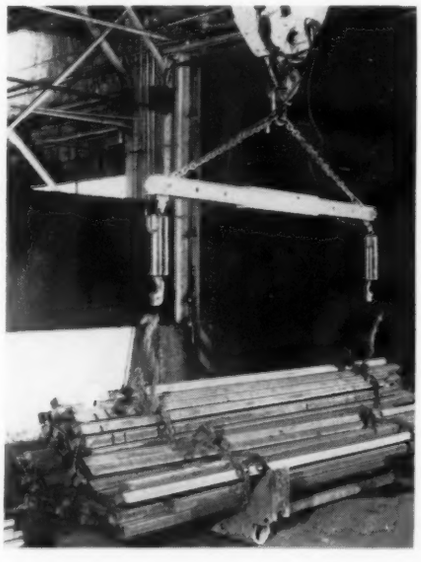
MOTORS

△ The Lima Electric Motor Co., Inc., a subsidiary of Consolidated Diesel Electric Corp. has announced a line of dripproof electric motors in new NEMA rerated frame sizes, from ½ hp at 900 rpm through 150 hp at 3600 rpm—frames 182 through 445 URS.

The newly designed frames are rigid, seasoned, cast iron with integrally cast feet. The cast iron endbells have precision machined

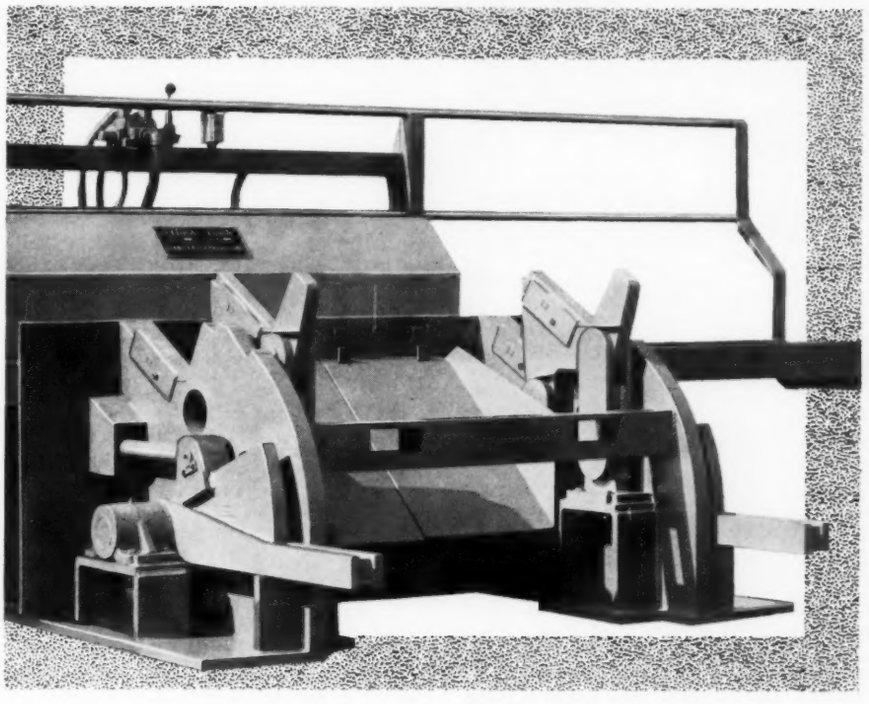
CHAIN RELEASE

The Acco Solenoid Chain Release, has been introduced to provide extreme safety in those operations where conditions make it dangerous for a worker to unhook the load. Permitting the safe release of those tough-to-handle loads without assistance, the unit is manufactured by the American Chain Division, American Chain & Cable Co., Inc. Originally designed for use in steel mills for soaking-pit operations, the new unit should find acceptance in other material handling jobs where bars, tubes, strips and similar materials are being transported with the aid of sling chains. The unit is remote controlled by the crane operator from his cab. By pushing a button, he activates the solenoids at each end of a spreader bar. This, in turn, expels the chain from its hooks and releases the load. Should the push button be pressed accidentally, or the power fail while the load is being transported, the load will not be released.



Slabs, Bars, Billets and Blooms conditioned faster, safer, more economically with special

TURNING DEVICES BY EVANS



- mechanized inspection tables for efficient inspecting or scarfing of round or square bars and billets.
- mechanical and hydraulic bloom and billet turners engineered to fit specific requirements and shop conditions.
- new mechanical slab and billet turner to speed the manipulation of slabs and billets for increased production and reduced handling time.

And along with Evans Turning Devices you get qualified engineering assistance in the development and selection of effective feed mechanisms and supplementary materials handling equipment.

Write today for the new Evans descriptive two-color brochure

EVANS ENTERPRISES INCORPORATED
MASSILLON, OHIO

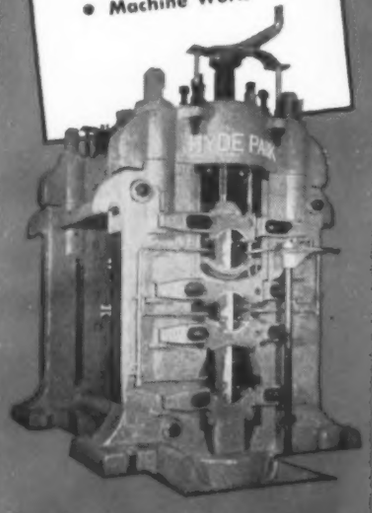
RED CIRCLE Rolls ALLOY-CHILLED

Hyde Park

Rolling Mill Equipment

For more than 50 years Hyde Park Steel Mill equipment has been helping American industry lead the world — equipment such as—

- Bar Mills
- Merchant Mills
- Sheet and Strip Mills
- Pinion Stands
- Roller Tables
- Reduction Drives
- Stretcher Levellers
- Guillotine Shears
- Sheet Mill Shears
- Roll Lathes
- Special Machinery
- Machine Work



For finer finish, long life and greater tonnage, specify Red Circle Rolls.

Hyde Park

FOUNDRY and MACHINE CO.

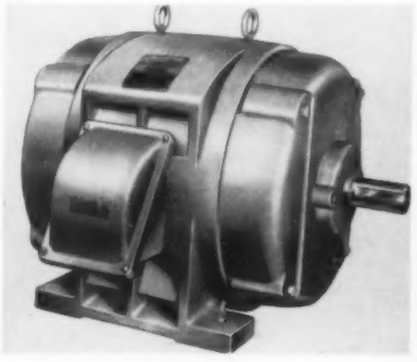
HYDE PARK

Westmoreland County, Pa.

Rolls
Rolling Mill Equipment
Gray Iron Castings

registers and bearing fits. Deep-drawn baffle plates in the endbells provide extra protection for the winding. Connection boxes can be rotated to make connecting easier.

The die cast aluminum rotors are equipped with dual cooling fans and the entire rotor assembly is dynamically balanced. Prelubricated sealed ball bearings require no



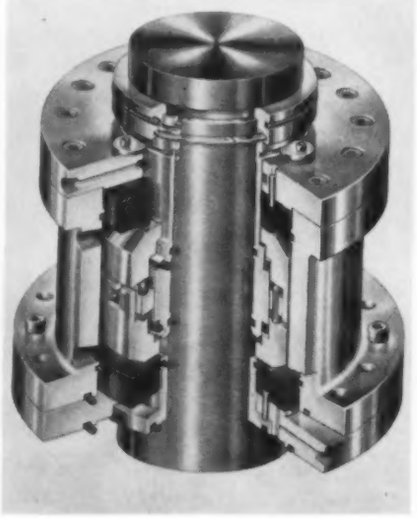
cleaning; the correct quantity of lubricant is sealed in, dirt and moisture are sealed out.

Stator windings are impregnated with moisture-resisting, thermo-setting insulating varnish, and are tested in accordance with NEMA specifications. Uniformity of the air gap between rotor and stator is accurately maintained for peak performance.

The motors can be furnished either 3 or 2 phase and in all frequencies and commercial voltages below 600 volts.

MECHANICAL SEALS

△ A new series of mechanical seals have beeen developed by The Garlock Packing Co. for installation on sealed vessel agitator shafts. Known as "Mechanipak" seals, they are completely self-contained



COMPLETE

QUALITY CONTROL

another advantage of

TM factory-made

alloy sling chains!

Taylor's well-known quality control —gamma ray testing . . . controlled heat-treating . . . professional inspectors—give TM factory-made Alloy Sling Chains the big edge over do-it-yourself types. Patented Tayco Hooks, stress-free links and Taylor's Certificate of Test are other advantages. Get all the facts. Call your distributor or write for Bulletin 13 today!

A full line of welded and weldless chain

CERTIFICATE OF TEST

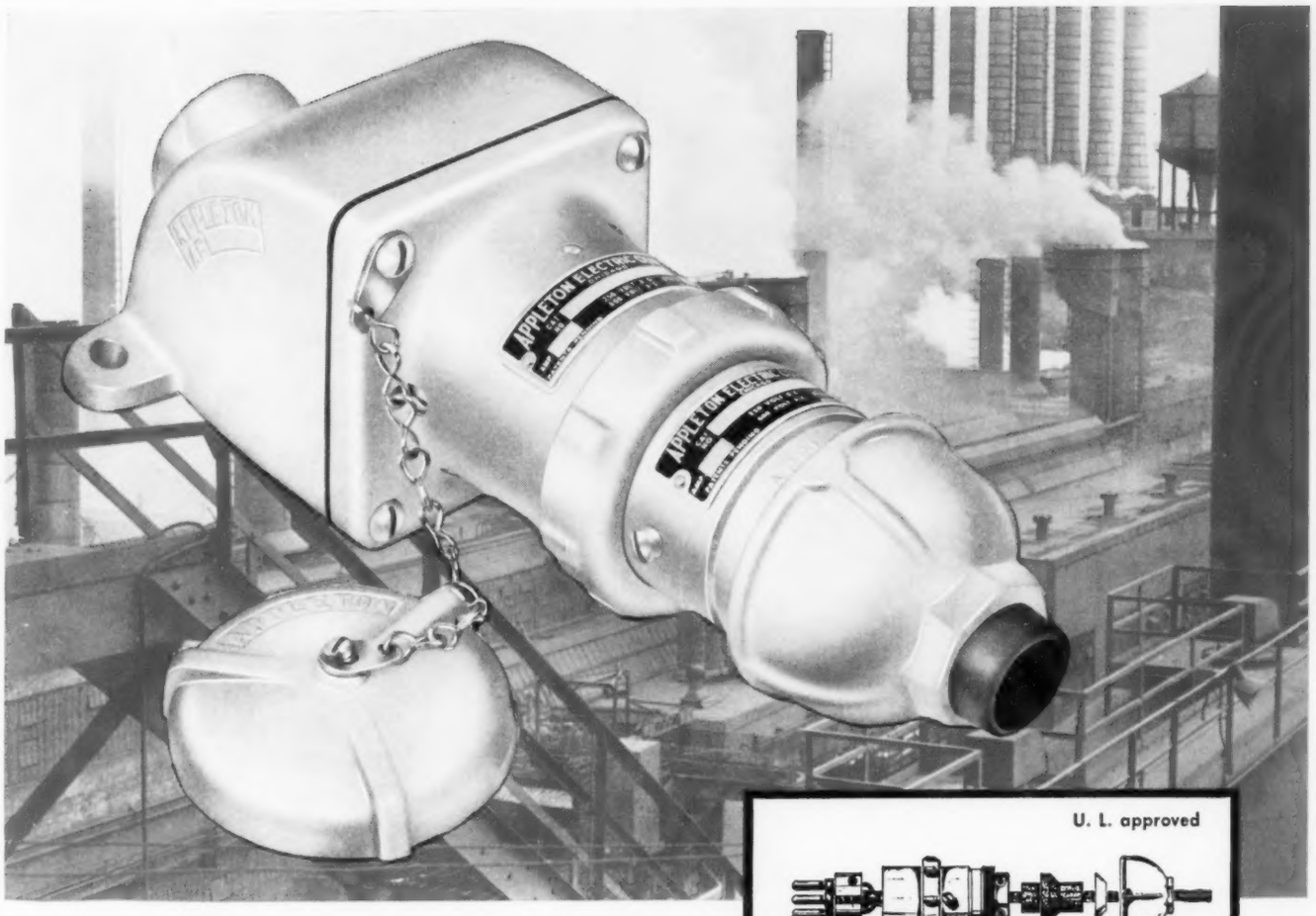
bears the chain guarantee, proof test and serial number.

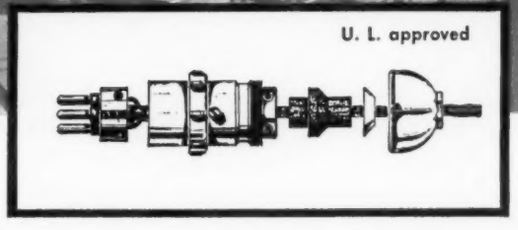
S. G. TAYLOR CHAIN CO., INC.
Hammond, Indiana
3505 Smallman St., Pittsburgh, Pa.

Taylor Made CHAIN SINCE 1873

APPLETON® "AE" SERIES

Plugs, Receptacles and Receptacle Fittings





Versatile, Precision Manufactured Plugs and Receptacles for Hundreds of Industrial Applications

The simple, sturdy construction of these APPLETON "AE" Series Plugs, Receptacles and Receptacle Fittings is your assurance of lasting, heavy-duty service.

Complete terminal units, equipped with solderless connectors enable connections to be made quickly with a minimum of effort. APPLETON "AE" Series Receptacle Housings are available in four styles to meet your specific requirements: Lift Cover Housing . . . Plain Housing . . . Threaded Housing . . . and Cap Housing. The Lift Cover Housing has a rubber-gasketed cover mounted on a self-aligning plate to form a dust-resisting enclosure which excludes chips, shavings, etc. Plugs are available with and without Clamping Ring. For utmost versatility and service life, APPLETON "AE" Series Plugs, Receptacles and Receptacle Housings offer an outstanding combination of quality features and economy of purchase.

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"The most rigid roll specifications can be met with National's modern facilities,"

says Jack Russell, Foundry Superintendent

"The modern equipment now installed at National gives us many checks on quality control in all steps of roll production.

"For instance:

- Flexibility gained by our wide range of furnace sizes permits casting rolls to meet your individual needs.
- Automatic heat treating and quenching equipment with electronic controls assures that more exact physical properties can be attained.
- Testing of steel rolls with the latest in ultrasonic equipment before heat treatment and again prior to shipment assures metallurgical soundness and freedom from flaws.

"These and other steps in the manufacturing, testing and inspection of National rolls—both iron and steel, plain or grooved—result in exceptional performance in rolling mill operations.

"Let National rolls prove this in *your* stands."

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National Roll & Foundry Division

Avonmore (Westmoreland County) Pennsylvania

General Steel Castings Corporation: General Offices, Granite City, Ill.

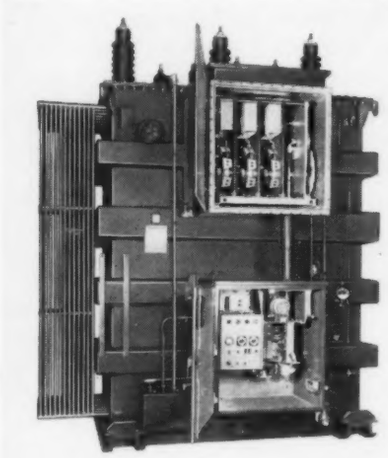
Plants: Granite City, Ill.—Eddystone, Pa.—Avonmore, Pa.

in a single unit for simple, quick installation.

The units are designed to prevent agitator shaft leakage at pressures up to 3000 psi and to withstand temperatures in excess of 700 F, even in corrosive environments. The seals are currently available in sizes to fit any shaft.

TRANSFORMERS

Δ Three-phase load tap changing power transformers, with plus or minus 10 per cent voltage regulation in $\frac{5}{8}$ per cent steps, using magnetic amplifiers in the voltage sensing circuit to initiate a tap change when required, are available from Wagner Electric Corp. Their use results in accuracy of control, since the amplifiers can be set to function at precise limits, and in reliability of operation, since they have no moving parts.

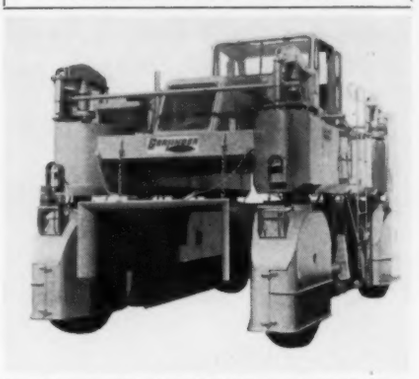


A single main drive shaft, coupled to the drive motor and to the drive pinion of the transmission assembly, provides direct, positive actuation of the tap changing switches. Devices for operating position locating switches, position indicator, operation counter, etc., are mounted on the main shaft, holding the number of gears required to a minimum.

Only two Geneva gears are used in the transmission assembly, one to operate the load transfer switch and the other to operate the tap selector switch and, at the proper time, the reversing switch. Mechanical stops on the tap selector gear in addition to electrical stops prevent overtravel in either direction.

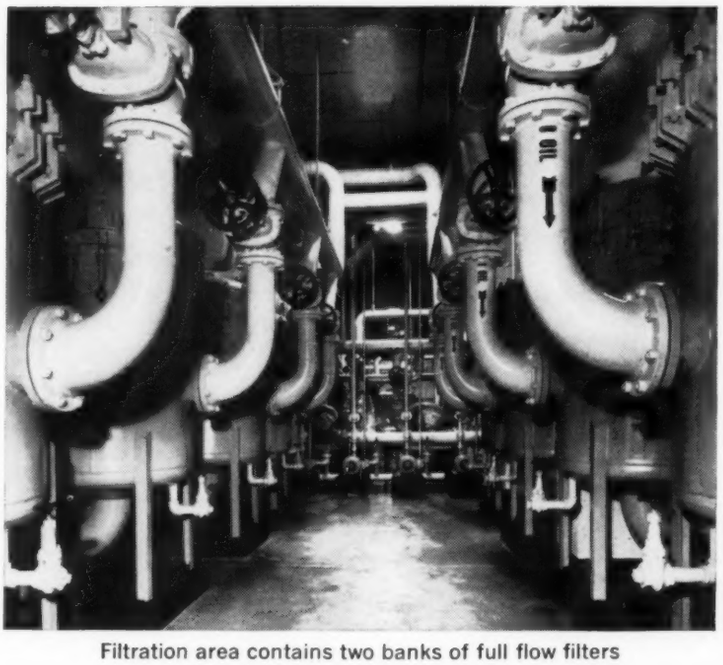
A feature of the moving contact shoes of the tap changing switches is their free parallelogram action, which allows them to adjust to, and exert constant pressure on, both sides

INSULATED LOADS



Gerlinger Model SC-60 material carrier shown here is used to transport hot ingots and plates. Machine is equipped with a special insulating load cover in the form of a steel plate canopy which covers the load and protects the driver and the machine's operating mechanism from the heat of the hot metal. Insulating load cover is completely independent of the carrier's hydraulically actuated swinging shoes and is raised with the load. Unit has 60,000-lb load-carrying capacity.

Dual Dravo-DeLaval coolant systems for new 31-inch cold strip mill



Filtration area contains two banks of full flow filters for cleaning mineral oil and water soluble coolants.

A new Sendzimer cold strip mill, built for the Scovill Manufacturing Company, Waterbury, Conn., which will roll both aluminum and brass, is equipped with a twin, custom-designed Dravo-DeLaval coolant and lubricating system. One system supplies mineral oil when aluminum is being rolled, and the other soluble oil and water for brass.

The dual design permits instant switching of lubricants to match frequent mill changeovers. Coolant is supplied at the rate of 750 gallons per minute at a 350-foot head, and each system includes a 15,000 gallon 3-section reservoir. Dual pumps are provided, one for the coolant system itself, and one for the cooling circuit. Cartridge type, full-flow filters which remove foreign particles as small as 15 microns assure clean oil at the mills.

Completely engineered by Dravo, this unusual dual installation was quickly and easily put in service, and required no engineering time at the site. For information on how high efficiency, Dravo-DeLaval oil systems can save you time and money, write Dravo Corporation, Pittsburgh 22, Pennsylvania.

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of the stationary contact blades. All contact parts are made of materials best suited to provide good conductivity and good wear resistance. The contacts of the load transfer switch, the only one which interrupts current, are made of materials selected for their ability to withstand arcing.

Simplification of design and ruggedness of construction is stressed throughout, to make the mechanism accurate, reliable, long-lasting and quiet in operation.

GAS BURNER VALVE

△ A water-cooled gas burner shut-off valve, the first of its type available for use on blast furnace stoves, has been developed by William Bailey Co. The unit, which requires only 11 seconds to move from fully open to fully closed, is intended to replace components which require two minutes or more for operation.

Designed to reduce greatly the time required for changing blast furnace stoves, while assuring a gas-tight seal, the valve is mounted directly to the stove. It bolts tight to the burner and stove saddle, thus preventing gas leaks at the burner. The unit's motor-operated drive unit and push button controls are located on a platform well above the valve and clear of stove heat.

Feature of construction is water cooling of the valve body and disk. This protects the component parts in operating temperatures which range to 1900 F and more. The valve currently is available in sizes 32, 39, 48 and 56 in. in diameter, for burning 12,000 to 35,000 cfm of gas. It is applicable for use with push button operation or on complete automatic stove change systems.

V-BELT DRIVES

△ A new line of standard v-belt drives incorporating interchangeable, quick detachable (Q-D) bushings has been announced by The American Pulley Co. The new fixed pitch, standard sheave drives, called American Q-D-V, can be easily mounted on and removed from the shaft for easy maintenance.

From a design standpoint, the Q-D bushed sheaves are interchangeable with a wide range of equipment drives such as conveyor pulleys, fan drives, sprocket drives, couplings, and timing belts. The drives are designed to handle any power requirements from 1 hp to 1500 hp with speed ratios up to 8.55 to 1.00.

The bushings for standard—A, B, C and D—cross-section belts are interchangeable with the Q-D bushings used on the larger sizes of the newly developed, compact 3-5-8 v-belt drives.

METERING VALVE

△ Development of a new metering valve, featuring a 40-pitch thread and needlepoint flow control in the 0 to 4000 cm/min air flow range, is announced by Nuclear Products Co.

Applications of this new micrometric fine-flow control valve range from gas analyses and sampling lines to meeting extremely delicate measuring requirements of burettes. Service in research lab sampling systems, spectographic and chromatographic work are just a few of the fine-metering valve's many functions.

The valve operates by simply

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turning the knurled cap. Ten full turns open the valve to maximum flow. No backlash or initial flow surge occurs in adjusting this valve for the most delicate fine flow control.

Each valve has a stainless steel 316 stem to assure high strength and maximum corrosion resistance. The needlepoint on each stem is ground from centerless ground bar stock to provide close tolerance concentricity. Threads are protected from stream corrosion by sealing below the threads. Rugged design and protective construction prevent damage and contamination.

The valve is available in brass and stainless steel.

CONTROL CONNECTORS

△ A new series of equipment control connectors of high durability and safety, for applications up to 600 volts, has been developed by Joy Manufacturing Co., Electrical Products Division.

Constructed of Neoprene, the connectors are crushproof, corrosionproof, waterproof and dirtproof. Molded-to-cable design allows severe or repeated flexing without breaking connector-to-cable bond.

Connectors are available in three basic styles: oval, round and dual round—from 2 to 12 poles.

Receptacle units are designed to fit standard types of outlet boxes common to factory wiring installations. Round series fits all standard FS and FD boxes. Hinged receptacle cover locks portable connector firmly in place when fully engaged.

Other principal features are: noninterchangeability; shrouds on male portable connectors to protect contacts and assure positive seal; numbering of all contacts on connector faces for positive identification.

Book Reviews

"**Handbook of Practical Electroplating**" by Thomas M. Rodgers, has been recently published by the Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. The book contains 333 pages, 7½ x 5 in., is cloth bound, and sells for $8.50. The book covers in encyclopedic form, actual practices of plating shops as well as theory background of plating, ranging from abrasives, acid dipping (pickling), and acti-

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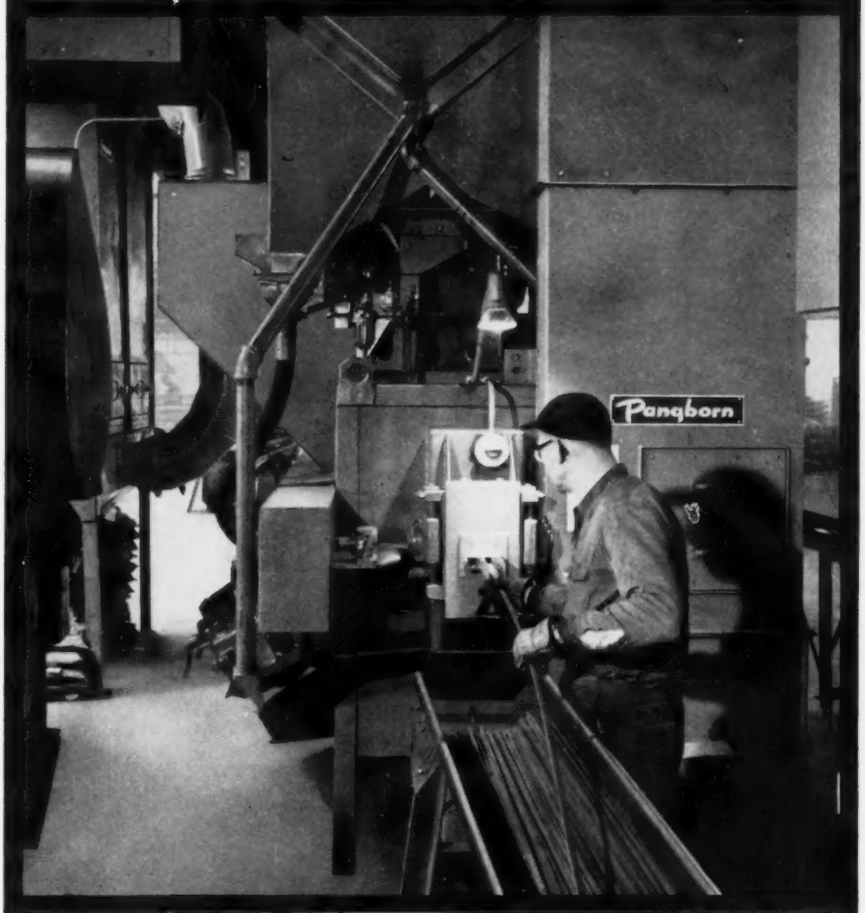

Pangborn Rotoblast Descaling Machine makes cost-cutting automation possible at Bustin Steel

At Bustin Steel Co., Dover, N. J., hot rolled steel bars are descaled by a Pangborn Rotoblast Machine at rates up to 180 linear feet per minute. This speed of operation plus the perfect quality of work—eliminating oiling and degreasing operations later—permits inserting this Rotoblast Machine directly at the head of the production line, working toward a completely automatic manufacturing operation.

The operating cost of this machine saves Bustin at least $75 a day compared to pickling, *plus* the cost of degreasing *plus* savings resulting from longer tool and die life.

For information on how Pangborn Rotoblast can save *you* money, write PANGBORN CORP., 4400 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Blast Cleaning and Dust Control Equipment and Rotoblast Steel Shot and Grit.*

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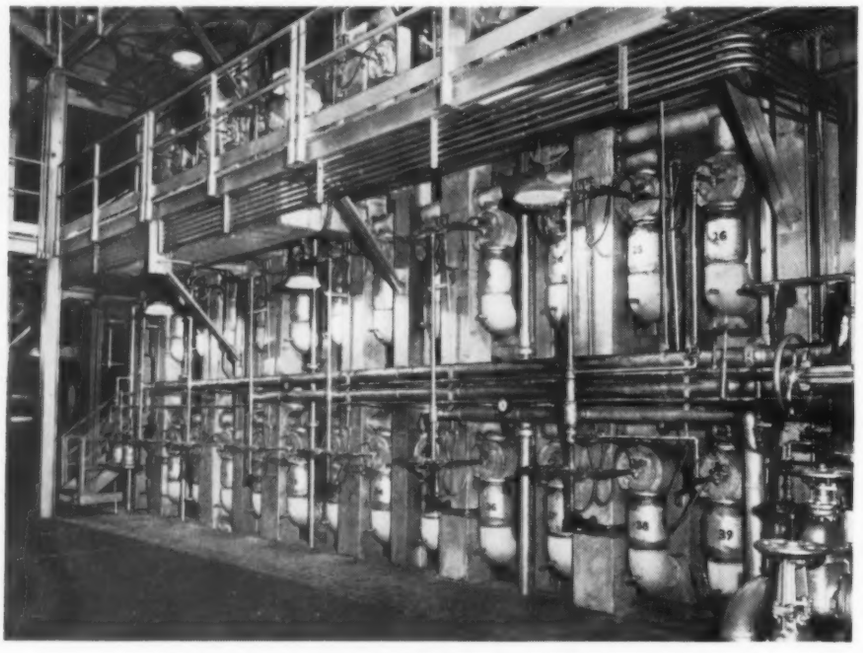
vated carbon to zinc-base die castings, plating on zinc plating and zirconium plating. Fomulas for all the basic plating baths, sections on the installation and maintenance of equipment, on salt-water gilding and immersion plating are included. Decorative color problems are emphasized. Each type of plating is described in terms of its industrial uses, equipment, solution composition, operation, maintenance and analytical control of solution.

"**Concise Dictionary of Science,**" by Frank Gaynor, has been published recently by the Philosophical Library, Inc., 15 East 40th St., New York 16, N. Y. The book contains 546 pages, 5½ x 8½ in., is cloth bound and sells for $10.00. Here is an up-to-date dictionary of concise definitions of terms and concepts pertaining to all fields of science: physics—mathematics—nucleonics–astronomy–chemistry. The newer sciences such as virology, ensymology, cytogenetics, radiochemistry, high energy and solid state physics, etc., are given full coverage. While the definitions given are concise, there has been no forfeiting of accuracy.

"**Serial Number Reference Book for Metalworking Machinery**" has been recently published by the Industrial Publishing Corp., 16239 Meyers Road, Detroit 35, Mich. The book contains 200 pages, covered in stain-resistant leatherette, and sells for $12.50. Useful to buyers or sellers of used machines, the new serial number reference book permits instant determination of the exact age of used metalworking machinery. Pocket sized book lists 1920–57 serial numbers of 226 leading machine tool manufacturers, who account for over 95 per cent of machine tools produced since 1920. Serial numbers are correlated with manufacturing date, year by year. Manufacturers are listed alphabetically.

"**Economics of the Mineral Industries**" (a series of articles by specialists), edited by Edward H. Robie, sponsored by the Seeley W. Mudd Memorial Fund, has been recently published by The American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., 29 West 39th Street, New York, N. Y. The book contains 755 pages, 6 x 9 in., is cloth bound and sells for $10.00, less 30 per cent to members of AIME, or $7.00. This book is a compilation of chapters prepared by the various authors (all specialists) covering various phases of mineral industries in the economy.

"**Automation, Cybernetics & Society,**" by F. H. George has been recently published by the Philosophical Library, Inc., 15 East 40th Street, New York 14, N. Y. The book contains 283 pages, 6 × 9 in., is cloth bound and sells for $12.00. This book gives an essential over-all picture of the subject. It treats the subject of automation and self-controlling machinery as part of the process of scientific planning, that is, as part of the evolution of science. The book discusses some of the social changes which scientific planning will bring, some space is devoted to the purely engineering side of the problem; some space also has been devoted to the effect of the new ways of thinking upon the psychological well-being of the individual, on his ethical attitudes, his religion and his creative arts. The subject is treated in a broad social context. Numerous illustrations are used.



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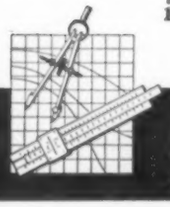
has brought about better and more efficient industrial furnace operation. Through the correct application of Bloom burners, combustion practice is improved and fuel costs reduced.



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We look inside your commutator at National

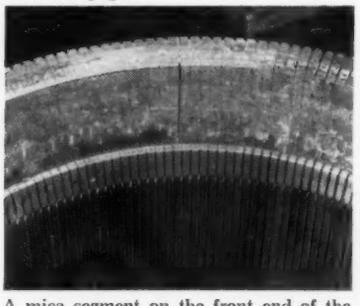
...The Specialists in electric coils/repair service

AND HERE'S WHAT WE OFTEN FIND!

Enlarged view of a dielectric puncture of a mica vee ring at the lower end of the copper bar. This is an example of interior commutator faults which may be present though exterior appears excellent.

Shifted or squirted mica at the apex of the 3° and 30° cone surfaces of a mica vee ring. The black lines on the 3°-surface were made by bar-to-bar voltage breakdown creepage.

The bar which projects above those adjacent has been locally overheated under a brush and softened.



A mica segment on the front end of the commutator has started to work out radially and will eventually result in a bar-to-bar short circuit.

When you send D-C machines to National for rewinding or rebuilding, the commutator gets a close inspection and test. But we've found from experience that a commutator that looks excellent on the surface may be in deep trouble inside . . . with mica cooked, varnish burned, loose copper, or imminent short circuits.

So when we are suspicious of the commutator we remove and open it for a close interior inspection. It's another added assurance that machines rebuilt by National will give you long, dependable service.

For more information, call National's Columbus plant . . . HUdson 8-1151. Or call the nearest National field engineer.

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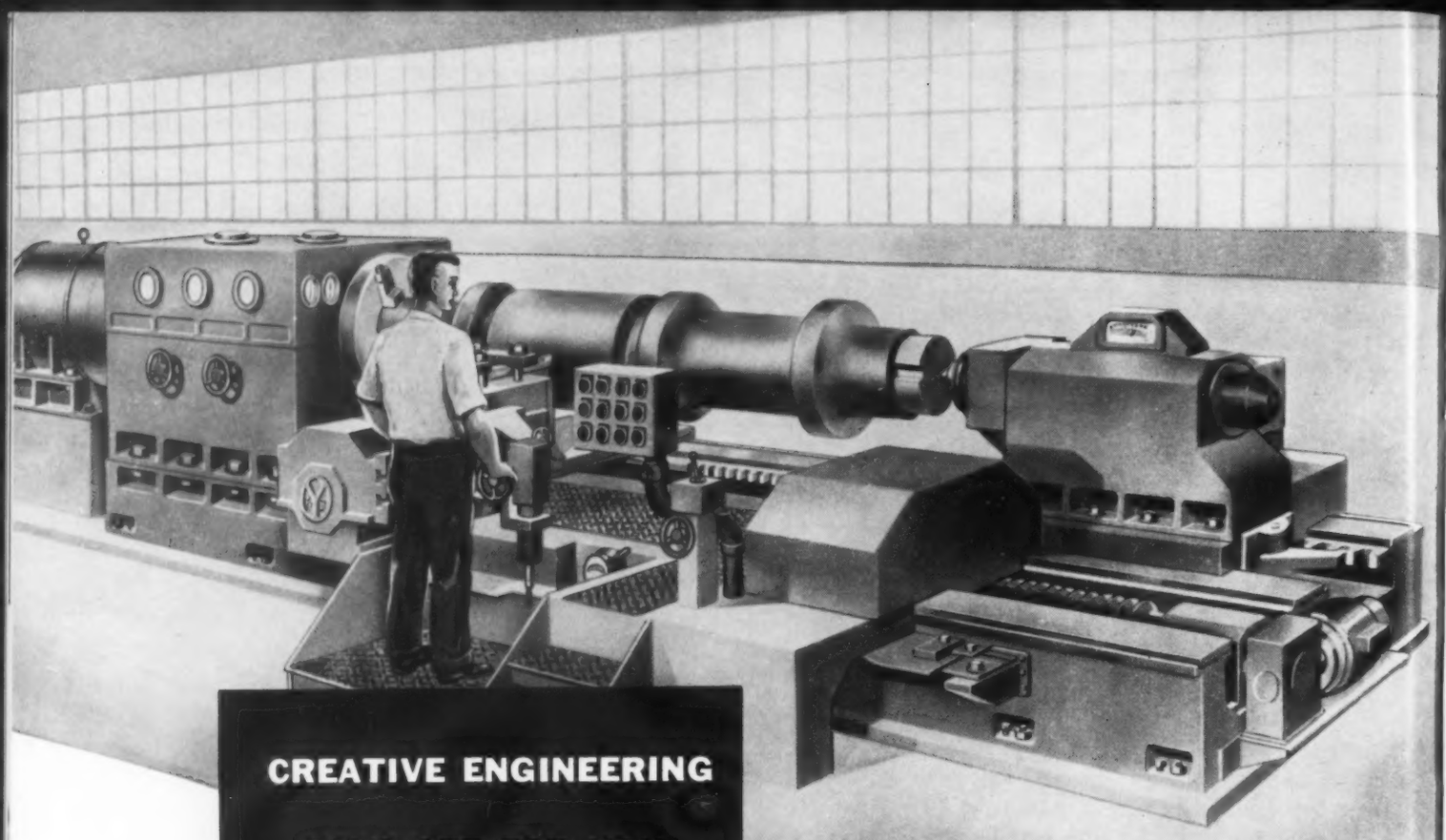

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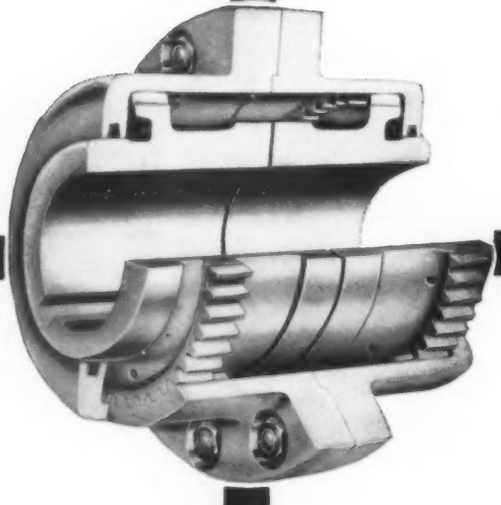

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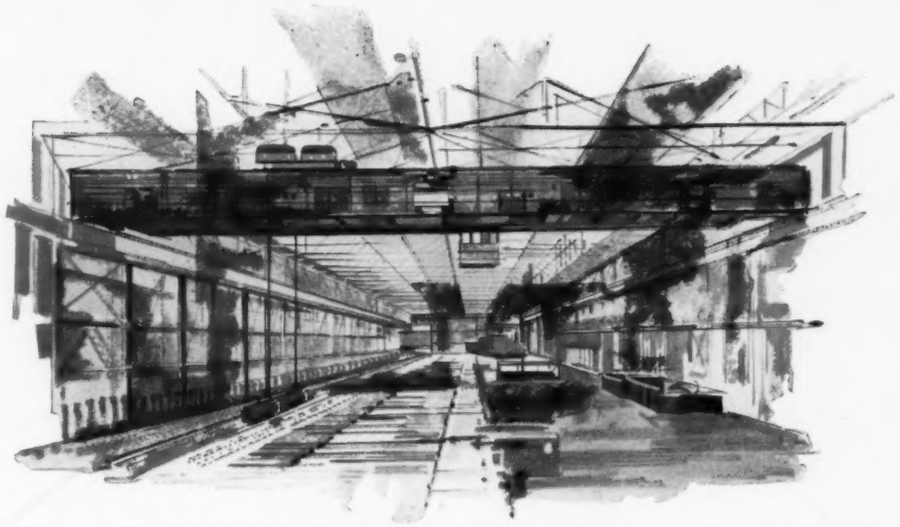

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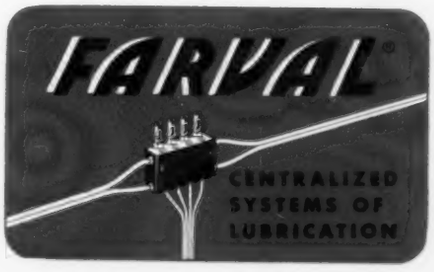

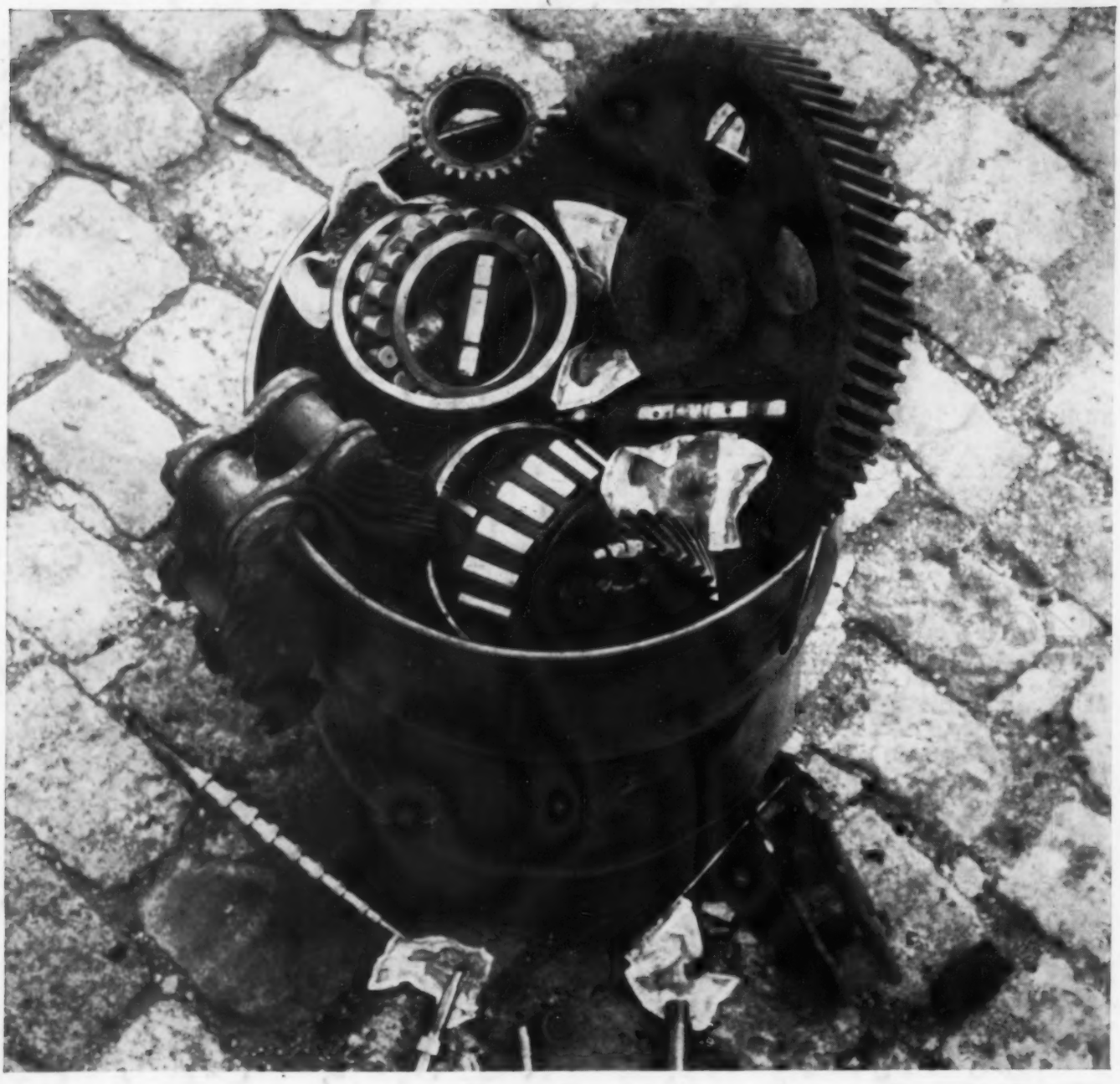

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